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AMERICAN RAILWAY JOURNAL.

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THE HUDSON RIVER TUNNEL has now been driven a distance of nearly 3,400 ft., and the shield is being advanced at the rate of 10 ft. a day. The last air lock is 1,200 ft. from the heading, and a new one, much larger than the others, is being built. No work has yet been done on the New York side, but a new shield is said to be ready and operations may be resumed at any time.

THE MEMPHIS BRIDGE FOUNDATIONS are completed, and all but one of the piers are now finished. The falsework and traveller for the anchor arm on the left bank have been completed, and the greater part of the material for this span has been received. Little work has been done on the east approach, but the foundations are finished for the steel trestles of the west approach. The recent floods have greatly delayed the progress of the undertaking.

A FOREST COMMISSION has been created in Maine by a law recently passed by the State legislature, and the State Land Agent is made Forest Commissioner. He is to collect statistics and report annually upon the forest interests and upon the extent and damage of forest fires. The bill imposes penalties for leaving camp fires burning in the woods. Railway companies whose lines pass through waste or forest lands are required to cut and burn or remove every year all grass, brush or inflammable material from the right of way, and to equip their engines with apparatus to prevent the escape of sparks and fire.

WORK ON THE SAULT STE. MARIE WATER POWER CANAL will be resumed as soon as the necessary land is obtained. The Dominion Government owns a tract which is required by the Ontario & Sault Ste. Marie Water Power Canal Co., for whom the work is being done, in order to enable it to increase its facilties at some future time if so desired.

TWO GEARLESS ELECTRIC CAR MOTORS have been recently perfected. The first of these, manufactured by the Short Electric Railway Co., uses an armature mounted on a sleeve turning loosely on the axle of the wheels, and connected with the latter by heavy spiral springs, in the manner used so successfully in the Ball engines. The other motor is made by the Westinghouse Electric & Manufacturing Co. Its armature is of the drum pattern and is wound directly on the axle. Both motors are ironclad and are much more simple than the older forms with one or two reduction gears.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head collision April 5 on the Cincinnati Southern Ry., at Ludlow, Ky. A northbound freight train got from under the control of the trainmen while running down a steep grade and ran into a switch engine and several cars which were standing on the track. Two engines and about 12 cars were wrecked. One man was killed. The conductor stated that the brakes on a third of the cars were in bad condition. An express train on the Boston & Albany R. R. was derailed near Westfield, Mass., April 6, by a pile of ties placed on the track. The engine and two mail cars were thrown down the bank, the smoker and baggage car were thrown across the track, but the passenger and sleeping cars remained on the track. Nobody was seriously injured.

BRIDGE ACCIDENTS are reported as follows: On April 4 a derailed Pennsylvania R. R. freight train struck the pier of a bridge over the tracks at Thirty-third St., Pittsburg, Pa., damaging the bridge considerably. The Canadian Pacific Ry. bridge over the St. Lawrence River, at Lachine, near Montreal, has been damaged by the ice.

THE NORTHWEST BANK of the Mercer County reservoir, near Wapakoneta, O., gave way April 2, and a large section of country has been flooded. The Coralsville dam, near Iowa City, Ia., gave way April 4. It was built in 1869.

TWO FIFTY-TON traveling jib cranes have been designed by the Bureau of Yards and Docks for use in placing armor plates on the sides of war vessels. They will be sent to the navy yards at New York and Norfolk. The jib will have a radius of 50 ft. and a 75 ton counter-weight is provided. Proposals for the construction are asked.

THE SERVE BOILER TUBE, described and illustrated in our issue of Nov. 8, 1890, is being tested in comparison with plain tubes by Mr. H. B. ROELKER at the works of Samuel L. Moore & Sons Company, Elizabeth, N. J. The tests are being made with a vertical boiler, working for two days with natural draft, and two days with forced draft. The tests of the boiler with plain tubes were made on April 6 to 9. The plain tubes are now being removed and Serve tubes substituted. On April 15 and 16 the boiler will be tested with natural draft, and the two following days with forced draft. The Serve tube is the invention of a French engineer, and consists in the addition to the tube of a number of thin longitudinal ribs, radiating toward the center. It is claimed that these ribs increase the power of the tube to transmit the heat from the flue gases. English tests reported in our issue of Nov. 8, showed an increase in evaporative efficiency of about 12% by the use of the Serve tubes.

THE REACTION AGAINST ENORMOUS GUNS for naval purposes still continues. Lord BRASSEY, in his paper before the Institution of Naval Architects on "Future Policy of Warship Building," said that the ponderous pieces which have of late been mounted on board ship will not be included in the main armaments of the battle ships of the near future. From 30 to 50 tons should be the limit of weight. Very large ships, too, were not favored. The dimensions of the battle ships of the future, he believed, should not exceed 10,500 tons.

A CHANCE FOR AMERICAN STEEL RAIL manufacturers is offered by the Government of New South Wales. Bids are about to be invited for the supply of 175,000 tons of steel rails, to be manufactured in the colony, the iron ore and the fuel used to be mined within its limits. The delivery of the 175,000 tons to begin in January, 1893, and continue during five years. The prices to be paid are to be determined on the basis of the average prices ending at the time of delivery in London or Liverpool. Bids will be received by the Minister of Public Works, Sydney, N. S. W., or by the Agent-General for the colony in London, up to June 24, 1891.

A RAILWAY COMMISSION IN TEXAS was recently established by the legislature. It will consist of three members appointed by the Governor and receiving $3,500 each per annum.

THE RAILWAYS OF VICTORIA, Australia, all built by the government, have fallen in cost from $200,000 per mile (double track) prior to 1862 to $50,000 per mile (single track) in 1863-7, and only $30,000 per mile since 1873. These figures exclude all rolling stock. Timber structures are used freely, but solid floors and rock ballast are carried over all iron bridges. The standard gage is 5 ft. 3 ins., and yet the sub-grade roadbed is only 15 ft. 6 ins., both in cuts and fills, with 1 to 1 slope in earth cuts. The ties are 9 ft. long. Wages range high—from $1.75 to $2 for common workmen and $3 per day for section foremen upward. The total population in 1889 was 1,104,000, of whom no less than 437,800, or 40.13%, lived within 10 miles of Melbourne post-office.

THE PROCTOR STEEL TOWER at the World's Columbian Exposition is to be 1,155 ft. in height, and will resemble the Eiffel tower in its general appearance. It will be hexagonal in plan, instead of square, however, and will have a larger base and start at a smaller angle with the vertical than the Eiffel tower. The designer of the tower is DAVID A. PROCTOR; the architects are Holabird & Roche, and the engineer is CORYDON T. PURDY, all of Chicago. The contract for erection has been let to the Geo. A. Fuller Co. The steel, of which 7,500 tons will be required, will be furnished by Carnegie, Phipps & Co. The elevators will be furnished by the Hall Elevator Co. The total cost of the tower is estimated at $3,000,000.

THE CENTENNIAL ANNIVERSARY of the establishment of the American patent system has been celebrated at Washington this week, the programme announced in recent issues being closely followed. WESTINGHOUSE, EDISON, BELL and GATLING are among the famous inventors who have been present at the anniversary exercises.

DUTY TRIALS of several Worthington compound pumping engines have recently been made in England, and are reported in a recent number of *The Engineer*. Four different engines, tested by different engineers, showed duties per 100 lbs. of coal (no deduction being made for ash or clinker) varying from 111,500,000 ft.-lbs. to 128,200,000 ft.-lbs.

THE HONDURAS NORTH COAST RY. project is now under consideration by English capitalists. The government has recently granted a concession to a French syndicate for a narrow gage line, 93 miles long, for the Pacific coast up the Rio Grande Valley to Tegucigalpa, the capital city. Concessions have also been granted to E. W. PERRY and T. M. IMBODEN, of the United States, for a telegraph line 100 miles long, a road 300 miles long and a canal 20 miles long, 36 ft. wide and 5 ft. deep, to connect the Caratasca lagoon with the Guayapa river. A large land grant is a part of the concession.

THE BENEVOLENT FUND of the Institution of Civil Engineers, England, which was established in 1864, now amounts to about $230,700. The income for 1890 was $15,850, of which $7,544 was derived from annual subscriptions, and $8,306 from dividends and interest. The disbursements amounted to about $522. Grants amounting to $16,338 were made in 64 cases, the highest number assisted in a single year. The amount voted for assistance exceeded the actual income, the deficiency being made good from casual benefactions. The committee in charge of the fund reports that, although the accounts show that the fund is well able at present to meet the calls upon it, the finances will never be in a really healthy condition until the number of annual subscribers bears a much higher proportion to the number of members eligible for assistance, and attention is called to the disproportion between the list of contributors to the fund and the list of members of the Institution.

AMERICAN MACHINERY is very favorably regarded in Australia, as most of our readers know. The *Australian Mining Standard* describes the electric plant for lighting the city of Newcastle, which has been recently put in by the Westinghouse Electric Co. The dynamos are run by Westinghouse compound engines, and steam is furnished by Babcock & Wilcox boilers.

Stone Arch Highway Bridge Over the Turkey River, Elkader, Ia.

The stone arch bridge here illustrated is said to be the longest and best constructed highway bridge west of the Mississippi River and east of the Rocky Mountains. Prior to the building of this stone structure the river at this point was spanned by several double iron trusses of the Truesdale type, which had been defective for years, so that repairs were frequently required to keep them in a passable condition. Finally the Board of Supervisors decided to take steps toward renewal, and secured the services of Mr. M. TSCHIRGI, Jr., the engineer of the high bridge at Dubuque, Ia., to examine the old structure and report as to its safety. He reported that it was unsafe and should be condemned, and the board concluded to authorize the construction of a stone arch bridge, as the location was suitable, the foundations on solid rock and the heavy annual expenses of replanking the floor of either an iron or wooden bridge would be avoided, while a quarry near town afforded an inexhaustible supply of magnesian limestone, free from imperfections, and known to be proof against the action of frost.

Bids were invited, however, for the construction of either an iron or stone bridge; but the bids for the same width of structure showed that an iron bridge of proper strength would be more expensive than stone at the price for which the contract was let. The general construction is shown in Fig. 1.

The contract for the structure illustrated was awarded to Messrs. Byrne & Blake, of Dubuque, for $13,000. There are 2 spans each 84 ft. in the clear, with a center pier 48 ft. long and 19 ft. wide at the foundation. Clear height of each arch, 27.9 ft.; radius, 45.56 ft.; outside width, 34 ft.; clear width, 30 ft.; entire length of bridge, 246 ft. The voussoirs are 3 ft. deep at the crown, 3½ ft. at the haunches, and 4 ft. at the skewback. The 24-ft. roadbed is macadamized; there is a gutter on the upper side of the roadway, a curbstone and a hexagonal block cement sidewalk 6 ft. wide. The shallow river has an almost level bed of rather shaly stone, and, by removing a small portion, it afforded a good foundation. The foundation course was laid directly upon it, the interior backing being well filled with hydraulic cement grouting, forced into and under the footing courses. The banks were high, and consisted partly of ledge rock. The centering was of very simple construction, as shown in Fig. 2, with no trussing, very little cutting of timber, and only a few short iron bolts. The 5 ribs contained about 50,000 ft. of lumber.

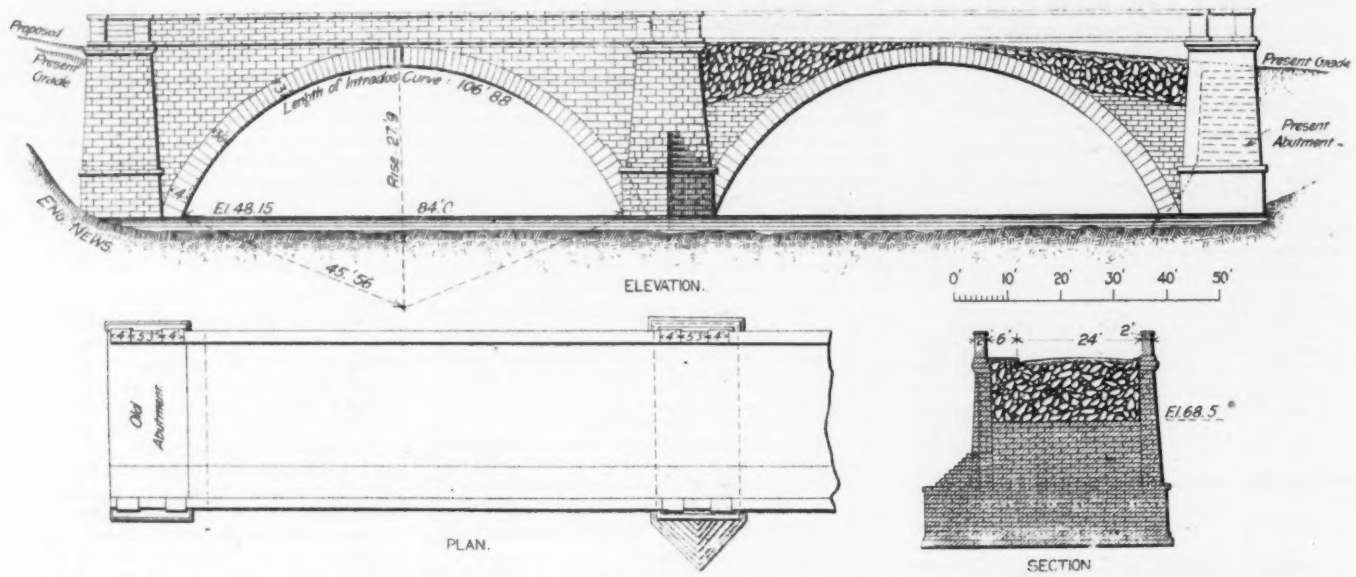


FIG. 1. STONE ARCH HIGHWAY BRIDGE ACROSS THE TURKEY RIVER AT ELKADER, IA. Mr. M. Tschirgi, Jr., Engineer.

FIG. 2. VIEW OF ONE ARCH, AND CENTERING.

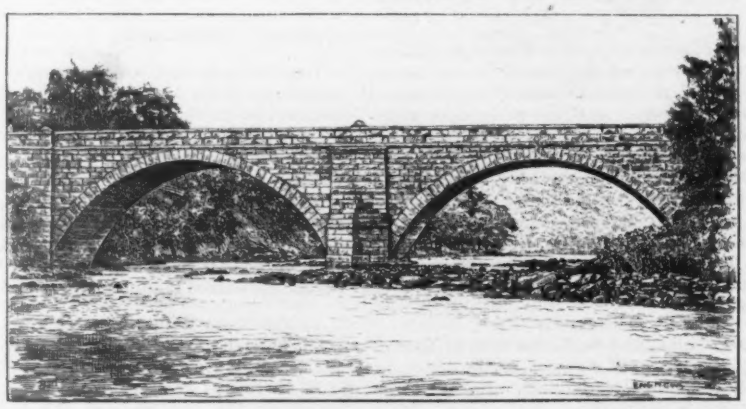


FIG. 3. GENERAL VIEW.

The contractors began work in September, 1888, and it required 9 mos. of actual work to complete it. There are 4,161 cu. yds. of material in the bridge, and its estimated weight is 18,618,255 lbs., or 9,309 tons. No one was injured nor did any accident of any description occur during the progress of the work. During construction the old structure was kept in position and open to traffic until a crossing could be effected on the new bridge, as shown in Fig. 2. In Fig. 3 is shown a view of the bridge, as completed.

The average crushing resistance of limestone is 7,000 lbs. per sq. in. The total vertical pressure on the skewback is 146,744 lbs., and the total horizontal thrust on the crown or key joint is 65,000 lbs. Mr. TSCHIRGI stated, in a paper presented to the Iowa Civil Engineers and Surveyors' Association, in 1889, that in practice the thrust at the crown has varied from 151 lbs. per sq. in. at the Waterloo Bridge, London, with spans of 120 ft, to 349 lbs. at the Chester arch bridge, with spans of 200 ft. Assuming 150 lbs. per sq. in. for the Elkader bridge gave for the voussoir a depth of 3 ft. at the crown, which was the depth adopted. Some doubt arose during construction as to whether there was sufficient friction due to the weight of the center pier and the semi-arch to withstand the horizontal thrust developed by the arch, as it was impracticable to construct both arches simul-

taneously, while the extra cost of centers would have been considerable. The horizontal thrust was 65,000 lbs., and the vertical pressure on the pier foundation 223,684 lbs. Assuming friction due to mortar at 10 lbs. per sq. in. gave 27,300 lbs. for a base of 19 sq. ft., and a coefficient of 0.4 for the friction of stone upon stone, gave 89,473 lbs., the total frictional resistance of 116,833 lbs., divided by the thrust of 65,000 lbs., gave a margin of safety of only 1.8. The work, however, was completed without injury.

The cost of the structure was in detail as follows:

By contract price, according to plan	$13,000
Extra wing walls, 264.1 cu. yds. @ $6	1,585
Extra in spandril walls, 73.9 cu. yds. @ $5	370
Extra excavation for wing walls	45
Extra coping, 60½ lin. ft. @ $2	121
Extra belting course, 60½ @ 50c	30
Four circular end caps	41
Two center caps	50
Cutting circular corners	25
Macadam, 33½ cu. yds. @ $1.50	50
Plank sidewalk	25
Culvert on west end bridge	25
Filling at east end bridge	20
Keeping roadway open for teams	150
Engineering and superintendence	765
Total	$16,282
Cost per lin. ft.	$66.18

Filter Gallery Washing, at Eureka, Cal.

One of the greatest of objections, in fact often a fatal objection, to the use of infiltration galleries for public water supplies is that, as generally designed, it is impossible to cleanse the filtering material. The latter gradually becomes so badly fouled that if it remains possible to get water through it the resulting liquid is sometimes more impure than before the process was begun. Or, if this is not the case, the rate of filtration becomes so slow that it is necessary to enlarge the gallery if the necessary quantity of water is obtained.

An ingenious method of back flushing and cleansing an infiltration gallery has recently been put in operation by the Ricks Water Co., of Eureka, Cal. Through the courtesy of the superintendent of the company, Mr. H. L. RICKS, to whom we understand that the credit of the plan is due, we are enabled to present the following description and sketch:

The water-works at Eureka were built in 1879 by the late C. S. RICKS. In 1889 the present company was organized to buy the works of the Rick's estate and to operate them. The source of supply until recently was a surface well, with four deep wells sunk in its bottom. The surface well was 20 ft. sq. and 47 ft. deep. The wells sunk in its bottom were 806, 293, 172 and 100 ft. deep, respectively.

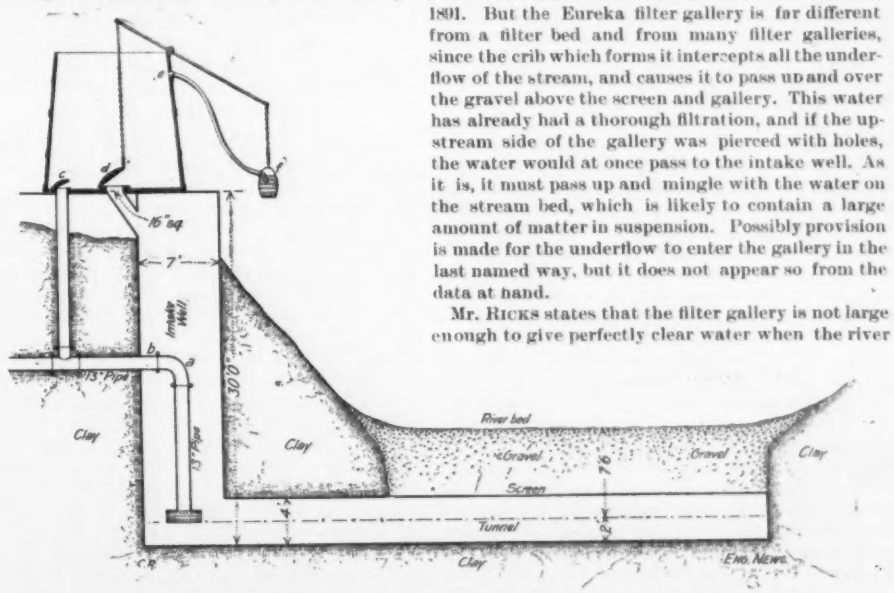
In 1889 the company began construction for a new supply, which has since been used with gratifying results. The new supply is pumped from Elk River directly to the distributing pipes through about 5¼ miles of 13-in suction and force main, the pumping station being about 6,000 ft. from the river.

As the river carried matter in suspension, purification was desirable and the bed of the stream being composed of gravel, the intake well was extended horizontally beneath the river, so as to form an infiltration gallery. This is shown by the accompanying sketch.

Before constructing the well and gallery a dam was built across the river about 100 ft. above them, and the natural flow of the stream was carried below the site of the gallery by means of a flume. The gravel at this point extended 7½ ft. below the water. A trench was therefore dug, 9½ ft. deep, extending for 2 ft. into the clay beneath the gravel, and across the whole of the gravelly bed of the stream. This trench cuts off the whole underflow through the gravel and causes it to pass over the filter bed. After making the trench, a crib 8 ft. wide, 10 ft. high and 64 ft. long, outside dimensions, was built within it. The inside of the crib, or gallery, is 6 ft. wide, 4 ft. high and 55 ft. long. The gallery is covered with a No. 14 iron screen, with ¼-in. perforations. The screen is 6 ft. wide and 40 ft. long, and above it is 4 ft. of gravel. This gives a filtering area directly over the screen of 240 sq. ft.

The intake well is 7 ft. sq. and 30 ft. in height from top to bottom. The intake or suction pipe is 6 ft. lower at the pumps than at the elbow *a*. A little air collects in the suction pipe, which, it will be remembered, is 6,000 ft. long. A vacuum gage at the pumping station warns the engineer when air is collecting in the pipe, and also when the water is becoming fouled, so that the filter needs washing. The air is removed from the pipe and the filter cleansed by the same back-flushing, as described below.

At the pumping station are two tanks with a combined capacity of 16,000 galls., which are kept filled with water, and are connected with the suction pipe. When the engineer sees that there is air in the pipe, or that the filtering material needs washing, he stops the pumps for about 20 minutes, and, opening the valves, admits to the suction pipe the water in the tanks at the pumping station. The back-flow through the suction pipe closes the valve *b* at the intake well, and opens the valve *c*. This admits water to the tank shown in the cut, and speedily fills it to the water line at the point when the hose connects with the tank at *e*. The water passes through the hose and speedily fills the 15-gall. cask *f*. The weight of this cask lifts the valve *d*, which is 16 ins. sq., by means of the lever connecting the two, and thus the contents of the tank are discharged down the intake and forced up through the perforated iron screen and filtering material. The contents of the tank,



SKETCH SECTION OF FILTER GALLERY AND WASHING DEVICE, EUREKA, CAL.
Designed by H. L. Ricks.

8,000 galls., are discharged in 65 seconds. The matter washed from the filter bed is carried down the river.

The gage at the station being a combined vacuum and pressure gage, the engineer can tell when the tank at the river has become empty and can then close the valves at the station tanks, and resume pumping. A small hole in the bottom of the cask at the river tank soon discharges the contents of the former, and the lever and the valve *d* being counterbalanced, the latter closes. When pumping is resumed the valve *c* closes, and *a* opens, and normal action is resumed.

When the notes from which this article is written were made the plant had been in use for six months, and had averaged a back flush once every 48 hours, without a failure. Mr. RICKS states that the arrangement could not be dispensed with.

In our issue of Nov. 1 we described the method employed to remove air from a combined suction and siphon pipe in connection with the water-works at Auburn, N. Y. The pipe at Auburn was 24 ins. in diameter, 9,560 ft. long, and was laid to conform to a very undulating surface, there being at least 18 changes in the grade. One of the Auburn pipes is 5 ft. below low water, and the others are 10 ft. above it. At some distance from the lake the pipe rises about 18 ft. above high water, but rapidly descends, until just before reaching the pumps it is considerably below low water, and somewhat lower than the lowest pipes. Air is removed by connecting a small air pump to an independent air pipe which taps the main pipe at points where the air gathers. At Eureka the operation which is in any case necessary or desirable in order to wash the filter removes any air that may have collected in the suction pipe.

As flushing is performed, on the average, but once in two days, and the tanks at the station hold but 16,000 galls., it is evident that, at the most, a little less than 3,000,000 galls. a year is all that is necessary for flushing, and thus the yearly expense is trifling.

The pump in use is a 1,500,000-gall. Knowles compound duplex, and the average daily consumption in 1890 is reported as 275,000. The 13-in. force main, which is nearly 4½ miles long, and, at a point 2½ miles from the pump, passes over a hill at an elevation of 147 ft., affords sufficient storage capacity to allow the stopping of the pump while flushing is going on.

If the efficiency of this filter gallery depended entirely upon downward filtration through the bed of gravel directly above the iron screen, the whole arrangement would be of little use. For the screen has an area of but 240 sq. ft., and the average daily consumption is reported as 275,000 galls., which gives a rate of filtration of about 6½ cu. ft. per sq. ft. of filtering material per hour, which is 13 times as fast as the rate recommended by Mr. JAMES KIRKWOOD in his "Filtration of River Waters," and about 125 times as fast as the rate proposed by Mr. W. B. RIDER for the filter bed at Bethel, Conn., described and illustrated in ENGINEERING NEWS for March 7, 1891. But the Eureka filter gallery is far different from a filter bed and from many filter galleries, since the crib which forms it intercepts all the underflow of the stream, and causes it to pass up and over the gravel above the screen and gallery. This water has already had a thorough filtration, and if the upstream side of the gallery was pierced with holes, the water would at once pass to the intake well. As it is, it must pass up and mingle with the water on the stream bed, which is likely to contain a large amount of matter in suspension. Possibly provision is made for the underflow to enter the gallery in the last named way, but it does not appear so from the data at hand.

Mr. RICKS states that the filter gallery is not large enough to give perfectly clear water when the river is muddy, but that it takes out the worst of the sediment. By carrying out the above suggestion the filtering capacity could be greatly increased, since all the filtered underflow would be secured and the bed would be left free to pass such of the water passing over it as was possible. The filtering capacity could be further increased by enlarging the gallery and the bed above it, a process which could be carried as far as economy in cost and operation warranted. A dam across the stream, below the gallery, is projected for future construction, which will readily permit such enlargements as may be desirable. At present only about one-fifth of the flow of the stream is utilized.

A 612,000-gall. Hegeman-Olyphant filter has recently been ordered for the works, probably to supplement the gallery, which, as stated above, does not remove all the sediment when the water is muddy.

It is evident that by raising the tanks at the pumps and river the pressure for back flushing can be increased to an extent only limited by the displacement and washing away of the gravel in the bed. Mr. R. SWEASEY is President of the company and, as has been stated, Mr. H. L. HICKS is Secretary.

THE STREETS OF WASHINGTON are now 238.2 miles long, and may be classified according to surface as follows: Asphalt blocks, 8 miles; sheet asphalt and tar, 75.4; granite, 24; wood, 6; cobble and blue rock, 12.5; macadam, 6; gravel, 33.5; unimproved, 78.2. Gravel roads are no longer built. Granite curbing, 6 and 8 ins. thick, are used on all new streets. Granite blocks were formerly laid on all streets where the grade was over 5%, but as sheet asphalt has been found to stand well on grades of 7% or 8% the use of granite will hereafter be discontinued.

Notes On English Railways.

(*Continued from p. 305.*)

LONDON & NORTHWESTERN RAILWAY.

This is one of the leading trunk lines, and has a system aggregating 1,876 miles. In the United States it is generally looked upon as the standard English railway, in the same way that the Pennsylvania R. R. is generally considered in Europe as the standard American railway. It is surpassed, however, in many ways by other lines; and one of the most important points in which it has been deficient has been in the use of continuous brakes. For a long time a chain brake was used, and then the simple vacuum brake, which it retained for several years in spite of numerous accidents. Within the last few years, however, an automatic vacuum brake has been adopted. This line forms the West Coast route from London to Scotland, and has done some very fast running in competition with the East Coast route, which was referred to on p. 136. The distances by this route from London are 400 miles to Edinburgh and 401 miles to Glasgow. The company's own line ends at Carlisle, on the Scottish border, 300 miles from London. The main line is from London to Liverpool and Carlisle, with a line from Crewe to Holyhead. There is also a system of Welsh lines reaching down to Swansea, on the Bristol Channel, and through cars are run to Bristol in connection with the Great Western Ry. and the Severn tunnel. The company runs a line of steamers across the Irish Channel between Holyhead and Dublin, and another between Stranraer, in Scotland (near Portpatrick), and Larne. This latter is approximately the route of the proposed Irish Channel tunnel. Among the principal places on this system, with their distances from London, are the following: Rugby, 82½ miles; Birmingham, 113 miles; Stafford, 133½ miles; Crewe, 158 miles; Shrewsbury, 163 miles; Chester, 179 miles; Holyhead, 264 miles; Liverpool, 201 miles; Manchester, 183½ miles; Leeds, 220 miles, Preston, 209 miles; Lancaster, 230 miles and Carlisle, 300 miles.

Track.—The track is of the standard English type, with bull head steel rails of about the maximum weight, 90 lbs. per yd. The cast iron chairs are fastened to the ties by 2 round spikes and 2 trenails, or 2 round spikes and 2 screw spikes to each chair. In some places steel ties are used of the pattern designed by Mr. F. W. WEBB, the Mechanical Engineer of the line. They are rolled steel ties of trough section, and have chairs made of steel plates riveted to the top. They are made of a milder grade of steel than that used for rails. Some of these ties have been tried on the Pennsylvania R. R. The earlier ties had the ends closed, but the later ones have open ends. With these steel ties, steel spring keys are sometimes used instead of the ordinary wooden keys to secure the rails in the chairs. The keys are driven on the outer side of the rail. The jaw of the chair against which the wooden key is driven has 3 or 4 horizontal grooves, the ridges between which cut into the wood and prevent the key from slacking back. The ties, of wood or steel, have a uniform spacing of 3 ft. c. to c. The rails are laid with square suspended joints, spliced by deep splice bars, which embrace the lower head of the rail. There are 4 bolts, having the heads outside; the outer bar being grooved to hold the bolt heads. On some of the branch lines each chair is fastened to the tie by two spikes or one spike and one trenail on the inner side and a trenail on the outer side. On such lines plain splice bars with four bolts are frequently used, and in some cases the nuts are on the outer side of the rail. Some side tracks on the Welsh lines are laid with flange rails, secured to the ties by fang bolts passing through the flange of the rail, the bolt heads screwing down on the flange. The two bolts in one tie are both on the outer side of the rail, while those in the next tie are on the inner side, and so on alternately. Over a viaduct at Stockport the track is laid with bridge rails on longitudinal timbers, as on the Great Western Ry. (see p. 174). Each rail has nine bolts on each side of the head and four bolts at each end. Wooden shims, cut to the shape of the base of the chair, are sometimes placed between the chair and tie. The ballast is generally broken stone, the lower part being coarser than the upper. Cinders and slag are also used. The ballast is usually even with the tops of the ties; in some places it is boxed up outside the rail to the middle of the chair, covering the ends of the ties, and in other places it covers the ties entirely, being filled in level with the middle of the chair.

The distance posts are of wood, and are placed on the left-hand side of the track going from London. The mile posts are upright planks about 6 or 7 ft. high, with a wooden block of triangular section on top, as shown in Fig. 30. The intermediate posts

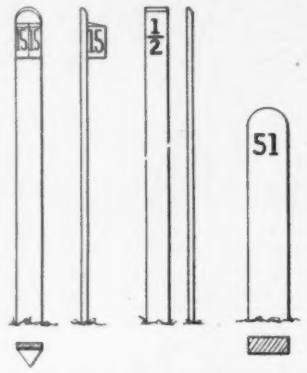


Fig. 30. Distance Posts; London & Northwestern Railway, England.

are similar, but without the block. The posts are painted white, with block figures nailed on and painted black. Another form of distance post, also shown in Fig. 30, consists of a post about 4 × 10 ins. and 4 ft. high. The mile posts of this style are set edgewise to the track, the figures facing the engine-driver, while the intermediate posts are placed with the figures toward the track. On some sections of the line stakes are placed upon which are painted the weight and make of rail, date when laid, etc. The usual form of grade sign consists of a short post with two arms which are inclined in the direction of the grades and have the grade painted on them. A form of grade sign seen on some of the Welsh lines consists of a rectangular board nailed to the stake or post. Two black lines are painted to show the direction of the grade, and the figures are painted above the lines. The semaphore blades are of steel, with a corrugation near the upper and lower edges to stiffen them. Those for the slow tracks are distinguished by a ring of a diameter about twice the width of the blade. The switch rods are now made of small channel irons, the joints being spliced by an inner channel bar and 6 bolts, with the nuts on top. At the connections with bell cranks, etc., they are swaged round. In some places round rods are used, with screw and cotter fastenings. Track tanks are laid at several points. At switches and crossings the guard and wing rails have a wooden block placed against each end; the top of the block is inclined so that nothing can catch on the end of the rail. The frames of bumper blocks, or buffer stops on side tracks, are frequently made of old rails bent to shape. Dead ends in terminal stations have buffer stops with spring buffers, or the hydraulic buffer stop, invented by Mr. WEBB, and described in ENGINEERING NEWS, Jan. 24. 1891. The line is fenced with a post and rail fence or hedge, or in some cases both are used. For removing chairs from the ties a wedge is used, which is driven between the chair and tie by a sledge hammer, raising the chair and drawing the spikes. On the London local line between Camden Town, Willesden and the Metropolitan Ry., the standard type of track is used, with gravel ballast sloped off from under each rail, leaving a part of the ends of the ties exposed. There is a cross-drain in the ballast between every fifth and sixth ties, but not at the joints. On the bridge by which this line crosses the main tracks at Willesden the chairs are secured to longitudinal timbers, which are badly cut by the chairs. The floor is of arched iron plates, with riveted joints. No ballast is laid upon the floor.

Near the Euston Square terminus, London, the line is in cutting, with curved retaining walls having a considerable batter, and braced by iron overhead struts. Some of these struts are plate girders with horizontal top chords and arched lower chords, and having a considerable bearing upon the wall. The walls are of yellow brick, now blackened by smoke and dirt. There are 6 tracks for some distance out of London, and 4 tracks to Wigan or Preston, 194 or 209 miles. On the line running from Swansea up through Wales there are some very steep grades of 1 in 70, 83 and 90 (1.43, 1.2 and 1.1 %), and winding sections of track in getting through the mountainous country. Some parts of this line are single-track, and are operated on the train-staff system. Between Tebay and Penrith, on the line from Liverpool to Glasgow, is the Shap incline, which has a grade to the north of 1 in 75 (1.33%) for a distance of 5 miles, up which a bank or pusher engine is generally used. After passing the summit there is a long down grade.

Locomotives.—Compound locomotives have been extensively introduced on this road by W. F. W. WEBB, the Mechanical Engineer of the line, who is the inventor of a three-cylinder system. A large number of engines of different types have been fitted to work compound, and are said to give satisfactory performance. The two high-pressure cylinders are outside the frames and drive the rear pair of driving wheels. The one low-pressure cylinder is between the frames, over or in front of the single leading axle, and drives the forward pair of driving wheels. In this way the use of coupling rods is avoided, where only four driving wheels are used. Compound engines with six driving wheels have the middle and rear pair connected by short coupling rods. The Joy valve gear is used on the compound engines. One of the compound passenger engines was described and illustrated in ENGINEERING NEWS, Jan. 26, 1889, and it is an engine of this class which is now in use on the Pennsylvania R. R., where it is said to be doing good work. Since then Mr. WEBB has brought out a larger class of engines of the same type, which is shown in Fig. 31. Some

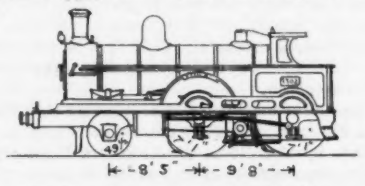


Fig. 31. Express Passenger Engine.

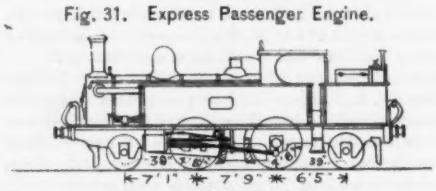


Fig. 32. Tank Engine.

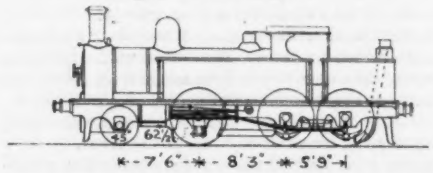


Fig. 33. Freight Tank Engine.

COMPOUND LOCOMOTIVES; LONDON & NORTHWESTERN RAILWAY, ENGLAND.

of these engines have the slide valve of the low-pressure cylinder placed underneath the cylinder. Among the principal non-compound passenger engines are those of the "Lady of the Lake" and "Precedent" classes. The former has outside cylinders 16×24 ins.; a single pair of driving wheels, 7 ft. 7½ ins. diameter, and a single pair of leading and trailing wheels, 43½ ins. diameter; wheel base, 15 ft. 5 ins.; weight, 60,480 lbs. The latter has inside cylinders 17 × 24 ins.; 4 coupled driving wheels 6 ft. 7½ ins. diameter, and a single pair of leading wheels 43½ ins. diameter; driving and total wheel base, 8 ft. 3 ins. and 15 ft. 8 ins.; weight, 73,808 lbs. There is still in operation the engine "Cornwall," which was built by Mr. F. TREVITHICK in 1847. It has cylinders 17½ × 24 ins., a single pair of driving wheels 8 ft. 6 ins. diameter, and a single leading and trailing axle. Fig. 32 shows a compound tank engine, in which the exhaust may be turned into the tanks. The driving wheels are fitted with brakes that can be applied by power or by hand. Fig. 33 represents a compound tank engine for freight service, which is a near approach to the American mogul type. The leading wheels are carried on a radial axle of a system invented by Mr. WEBB, and applied to engines

and cars. The front driving axle has coiled springs. The other driving axles have underhung plate springs with 15 leaves, which are connected by equalizing levers. The rear tank is fitted with the standard form of Ramsbottom scoop for taking water from track tanks. The dimensions of the three types of engines illustrated are given in the following table:

	Fig. 31. Express.	Fig 32. Tank.	Fig. 33. Freight tank.
Cylinders, h. p.	14 × 24 ins.	14 × 18 ins.	14 × 24 ins.
" l. p.	30 × 24 "	26 × 24 "	30 × 24 "
Diam. driving wheels	7 ft. 1 in.	4 ft. 8½ "	5 ft. 2½ ins.
" carrying "	4 " 1½ins.	3 " 8 "	3 " 9 "
" boiler	4 " 3 "	3 " 11¼ "	4 " 1 "
Tubes, number	225	179	198
" diameter	1⅞ ins.	1⅞ ins.	1⅞ ins.
" length	11 ft. 3 "	10 ft. 1 in.	10 ft. 4⅝ "
Boiler pressure, lbs.	175	160	160
Heating surface;			
tubes, sq. ft	1,242.4	908.87	1,001.25
fire-box, sq. ft.	159.1	84.84	94.60
total, sq. ft.	1,401.5	993.71	1,098.85
Grate area, sq. ft.	20.5	14.24	17.7
Driving-wheel base	9 ft. 8 ins.	7 ft. 9 ins.	14 ft. 0 ins.
Total " "	18 " 1 in.	21 " 3 "	21 " 6 "
Tank, U. S. galls.	.....	1,656	1,680
Weight; on leading wheels, lbs.	31,360	26,208	.....
front drivers, lbs.	34,720	34,720	.....
rear drivers, lbs.	34,720	34,944	.....
trailing wheels, lbs.	.....	18,032	.....
total, lbs.	100,800	113,904	97,440

Engines with inside cylinders have the slide valves generally placed in a vertical plane between the cylinders, or with large cylinders they are placed between them, near the upper side, at an angle of about 45°. The Ramsbottom duplex safety-valves are used on all engines. Cast-steel wheels are being extensively used. Freight engines have usually six wheels, all coupled. On the London suburban lines there are three classes of tank engines with four coupled driving wheels; 1, with inside cylinders and a single leading axle; 2, with inside cylinders and a single leading and trailing axle; 3, with outside cylinders and a four-wheel leading truck. It was noticed on the line running north from Swansea, in Wales, that on steep grades the engine threw showers of sparks and cinders, which rattled like hail on the roofs of the cars. Some of the red-hot cinders came in through open windows, scorching the cloth of the cushions. The automatic vacuum brake has been adopted; but some of the engines, including the small ones at the Wolverton car works, are fitted with Westinghouse brake pumps. The engines and tenders are fitted with a separate steam brake, which, however, is operated by the handle used for the vacuum brake. Clark & Webb's chain brake is also in use on some parts of the system. The engines of this road are painted black, with a small amount of gray and red striping and a little brasswork. Most of the passenger engines have names. The new compound engines, with their large driving wheels and high-set boilers, have a very fine appearance.

Rolling Stock.—This line runs dining, sleeping and drawing-room cars, all designed and built at the company's car works at Wolverton. One of the saloon cars was described in ENGINEERING NEWS, June 21, 1890. The ordinary passenger cars are 34 or 42 ft. long, the latter being now the standard length. They have steel underframes, which are built at Crewe. The body framing is mainly of teak, except the cant rail, which is of oak, and the paneling and sheathing are of mahogany. Light channel-iron roof beams are being used instead of wood. Cloth is not much used now for upholstering, carpeting or rep being preferred. High cushioned backs to the seats are fitted in all classes. The third-class compartments are 5 ft. 10¼ ins. wide between partitions, and have a space of 24 ins. between the seats. Some cars have compartments of the three classes, each with separate lavatory, and have a first-class coupé at one end. The first-class compartments have polished sycamore for the partitions above the cushioned back, and the roof is covered with "lincrusta." The roof of the third-class compartments is merely painted, with a slight striping stenciled on it. The lavatories are finished in accordance with the class: First class, paneled and finished in walnut and sycamore; second class, vertical teak match boarding; third class, vertical match boarding painted. The door frames are of mahogany and walnut. The difference in fittings for each class makes a great deal of work on every car. The third-class cars, 42 ft. long, have 7 compartments (accommodating 70 passengers). One end compartment is for smokers. These and many other cars are fitted with a novel arrangement of running gear. At each end are two axles, the outer one being on Mr. WEBB'S radial system, while the inner one is rigid. The older cars have two or three rigid axles. The Pope system of compressed gas lighting, controlled by the Pope Patent Lighting Co., of London, is in very general use, but the light is very poor and unsatisfactory. The trains are fitted with an automatic vacuum brake, which can on emergency be applied by the guard at the rear of the train. All through cars to Scotland are fitted also with the Westinghouse brake, as that is in universal use on the Scotch railways. The standard car wheel is 42 ins. diameter, with a wood filling and two retaining rings. The tires are about 2 ins. thick, and when removed from passenger cars are applied to light cars, horse boxes etc. The minimum thickness is 1 in. Grease boxes are generally used on the ordinary cars, but oil boxes are coming into more extensive use. The oil boxes in saloon cars have the covers bolted on, and run for a long time without refilling. Some of the car doors have a roller in the window-sill to reduce the friction of the leather strap in raising and lowering the sash. Spring roller blinds are much used. Large cars, like baggage cars, are used to carry the baskets of the parcels post. Some of the baggage cars are divided into compartments, each with wide double doors, so that baggage for different stations may be kept separate. A slate panel is fitted to each door, on which is marked in chalk the destination of the baggage within. The cars are painted a purplish brown or dark chocolate to the level of the window sills, and the upper part is painted a bluish white, with gilt striping. We shall have more to say of the passenger cars in a future issue.

The cars of some of the London local trains, running between Broad Street and Mansion House stations are very well fitted. They are short cars with 4 or 5 compartments, and are carried on 2 or 3 rigid axles. They are fitted with gas light and continuous brakes, the 6 wheel cars having squeeze brakes on the 4 outer wheels. The doors have handles inside and outside, and vertical strips of wood are fitted to the door frames to prevent passengers from getting their fingers crushed by the door. The second class cars are upholstered in red and black carpeting for seats and backs. The floor is covered by carpet between the seats, and oilcloth underneath. The sliding sash in the door when raised (or closed) rests on a movable strip of wood forming the inside sill of the window; when this is pulled forward the sash drops down into the panel of the door. In each door is a sliding ventilator above the sash. The windows are fitted with roller blinds, which are kept at any desired height by means of a bottom rod sliding in notched guides. The partitions are of sycamore, with darker wood for door and moldings. The roof is painted white. These cars seat ten persons in each compartment. Some of these local trains have the cars painted the standard style in chocolate and white, while others are painted brown all over. The latest practice, however, in consequence of the effect of the atmosphere of the tunnels of the underground railway upon the paint, is to have the natural wood rubbed down and varnished. The cars of these trains are generally

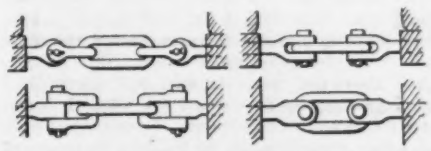


Fig. 34. Elevations and Plans of Short Couplings for Suburban Trains; London & Northwestern Ry., England.

coupled close together, and are not uncoupled except when repairs are to be made. They have couplings of one of the styles shown in Fig. 34, spring buffers of short stroke and slack safety chains.

Cattle cars are 13 ft. 6 ins., 15 ft. and 17 ft. 6 ins. long. Some cars used in freight service have a brake on one wheel, others have a brake on the two wheels on one side of the car, operated by a lever at the side. The brake shoes are of wood, and are used only in yards and at stations. At stations where freight cars are loaded, "loading gages" are used, under which large loads are run to see if they will pass through the tunnels and bridges. The loading gage is a curved iron rod, suspended from a gallows frame at the height of the lowest arch on the line. Sometimes bells are attached to the bar, so that when a load is too large it will warn the men in charge by striking the bar and ringing the bell.

Stations and Bridges.—At Crewe and some other stations the platforms are quite low, which is very awkward for passengers. Some of the smaller stations have the buildings of concrete. Some of the lavatories at Euston Square station, London, have an automatic catch on the closet doors, which is released by dropping a penny (2 cts.) into a slot in the door. At most stations of any importance in England there are lavatories, with an attendant in charge to supply towels, brushes, etc., and keep the place in order. The charge is generally 2 cts. for the use of a closet and 4 cts. for the lavatory. The Conway tubular bridge on the line from Chester to Holyhead is close under the walls of Conway Castle. The great bridge over the Mersey at Runcorn is a double-track through bridge with lattice girders. It has an iron floor, with angle-iron guard rails on each side of and at some distance from the track rails, forming a wide trough. The stone piers have castellated towers rising above the girders, and the portals are built like the entrances to a castle. The approaches are arch viaducts of blue brick. On the Welsh line from Swansea to Shrewsbury are some high masonry viaducts. There is a canal running parallel with the main line from London for a considerable distance. It has a winding course, and has numerous locks, some quite close together. Roads are carried over the canal by arch bridges of yellow brick with battering faces, spanning the canal and tow path. Balance drawbridges are also frequent. At several points along the main line light lattice through girder footbridges, with brick abutments, have been erected to allow footway crossings to be closed.

Operation.—As a rule, the main line trains keep time fairly well, but trains into London are often 15 to 30 minutes late. A ride from Liverpool to Glasgow, about 200 miles, showed some very poor running, the train being 20 minutes late at Preston, 25 at Lancaster, 50 at Tebay, 45 at Penrith and 60 at Glasgow. The guard signals the engine-driver when to start by blowing a whistle and waving two flags, one white and one green, the former indicating that the gage in the guard's van shows a vacuum of 15 ins. for the brake. The official instructions, which are issued periodically, mention the stations between which ballast trains may be expected, and order the enginemen, guards and brakemen to keep a sharp lookout and to pay particular attention to signals between these stations. Agents, foremen, signalmen and others are required to keep a sharp lookout for ballast trains, as they may be expected at any time during the day. The several agents on the branch lines arrange the working of the train staff with the ballast trains so as not to interfere with the regular traffic. Crewe station has a very busy and complicated traffic, lines running from it in all directions. Persons wishing to go on the platforms must purchase a ticket, the charge for which is about 2 cts.

Crewe Works.—The company has practically established the town of Crewe, nearly all of the male inhabitants being connected with the locomotive works or the line. Mr. F. W. WEBB, Mechanical Engineer of the line, is the mayor. The population is about 30,000. The houses are mostly of red brick, with white stone and blue brick trimmings. The streets are macadamized, and have sidewalks of blue brick, laid in ⌊ or ∨ courses. The gutters and crossings are of small square stone blocks. The works are very extensive, including a bessemer steel plant, rolling mills for rails, ties, shapes, plates, etc., and the usual machine, fitting, erecting and other shops. Some of the older shops are very crowded, and not well lighted. Cast steel driving wheels are made here, and are giving very good satisfaction. The steel tires are made from blanks, which are punched through by a steam hammer and then have the opening widened out to the required diameter. Old tires are rolled into the deep splice bars which are used with the standard type of track. The rail ends have the two bolt holes drilled at the same time. Among the interesting tools is a horizontal hydraulic hammer, with the two tups running on wheels. Switches and frogs are also made at these works.

Wolverton Works.—At the company's works at Wolverton, 52 miles from London, are built all kinds of passenger cars, and other cars which are run on passenger trains, including fish cars, milk cars, horse boxes, carriage trucks, etc. The works cover

50 acres of ground, and many of the shops are comparatively new. The shops are lofty, airy and light, and are well arranged. They are built of brick and have iron roofs. The machine shop has some very fine tools and a number of special machines for making all kinds of bolts, nuts, etc. There is a continuous line of shafting carried on a girder along three sides of the shop and into an extension. This is driven by an engine of about 150 HP. In the extension are the lathes for turning the car axle journals. After being turned, they are polished by oiled emery cloth placed in a wooden clamp which embraces the journal, and is held by the machinist as the axle revolves. The journal is finally polished by leather held in the hand until it has a very fine finish. The solid teak filling of the car wheels is forced into the tire by a hydraulic press, giving a pressure of 3 tons per sq. in. The plates for the springs have the ends cut and the center hole punched while cold. The ends are then heated, and the stud and recess, which fit the plates together are stamped. After being put together, the spring is tested in a hydraulic press and then straightened in a steam press, when it must recover itself exactly. A hydraulic press is used for forcing the straps off old springs, the pressure shearing the heads of the rivet which passes through the plate and strap. In the woodworking shop are revolving cutters which plane the wood very smooth, and give it a fine surface. There are numerous machines for grooving and shaping the various pieces of timber used in the framing. There is also a large planer which takes a clean shaving off the entire width and length of a large teak plank. The machinery in the woodworking shop is driven by a 50 HP. engine. Mr. C. A. PARK is the superintendent of the car department. The company's works for freight cars are at Earlestown, between Liverpool and Manchester.

Steamers.—The company's steamers running across the Irish Channel between Holyhead and Dublin, a distance of about 70 miles, are side wheel boats, with open decks, of the usual English type for this class of service. The one that came under notice was the "Shamrock," built by Laird in 1876 and fitted with oscillating engines. The cabin capacity is very deficient and inadequate, as on the steamers of the Great Eastern Railway, referred to on p. 213. As on most English built steamers there is no pilot house, the steering wheel being on the opon deck just in front of the engine room skylight, between the paddle boxes. The engine room telegraph stand is a little distance forward of the wheel, and a boy is stationed to attend to it. When in the open channel the officer in charge walks the deck, but on approaching the harbor he ascends to a narrow bridge between the tops of the paddle boxes, and shouts his orders to the men at the wheel and the boy at the indicator. This plan affords many chances for accidents by a misunderstanding of orders. The whole arrangement appears very crude compared to the American plan of having a large and comfortable pilot house placed high up and well forward, equipped with steering wheel, engine room indicators, bell and whistle ropes, etc., all handy to the pilot or captain. It may be noticed here that many English built ocean steamers have a wheel-house under the bridge, but the wheel regularly used is on top of this wheel-house, on a level with the bridge. The steersman is thus exposed to the weather, and in bad weather has to get what shelter he can from a piece of canvas triced to the rail of the bridge. The plan was probably devised with the same idea which led the early builders of English locomotives to build their engines without cabs; namely, that a man exposed to rain, cold and wind would be more on the alert than one sheltered from the weather. The baggage arrangements at Dublin are very unsatisfactory. The passengers landing at about 10 P. M. are turned into the station of the Great Southern & Western Ry. and stand about in the poorly lighted train shed in front of a large counter upon which the porters pile the baggage promiscuously, leaving the passengers to pick out their own property and remove it. Apart from the ease with which baggage may be stolen there is a large chance for mistakes in the confusion and bad light, in selecting individual trunks and valises from a large number, many of which are much alike. E. E. R. T.

(To be continued.)

The New Reservoir at Ashland, Ky.

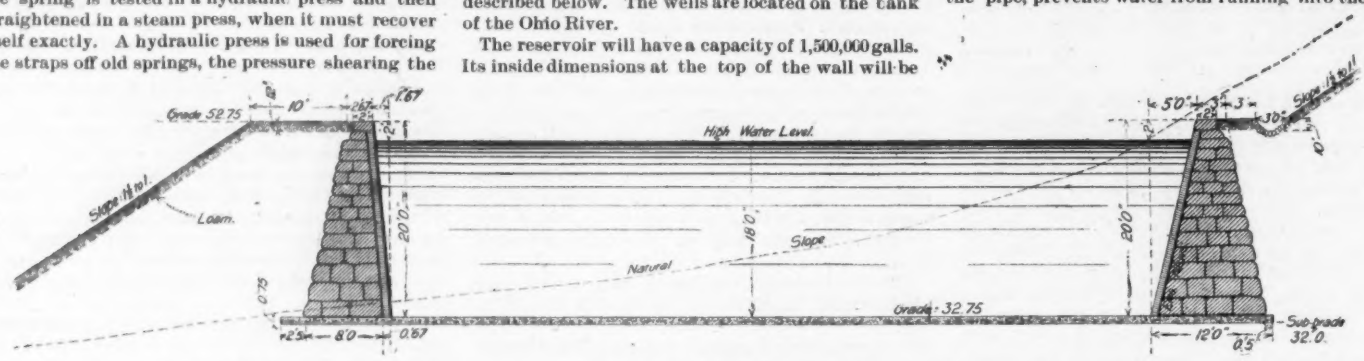
The Ashland Water Supply Co. began the construction of works in August last, and expects to put them in operation during the coming June. The supply will be pumped from driven wells to a reservoir, shown in the accompanying cross-section, and described below. The wells are located on the bank of the Ohio River.

The reservoir will have a capacity of 1,500,000 galls. Its inside dimensions at the top of the wall will be 78½ × 247 ft., and at the bottom of the reservoir 71 ft. 10 ins. by 243 ft. 8 ins. The depth of the reservoir at the center line is 20 ft., and it will contain 18 ft. of water. The reservoir is rounded at each corner to a radius of 10 ft.

As will be seen by referring to the illustration, the reservoir is located on a hillside, and the natural drainage of the latter is intercepted by a paved ditch extending along the upper side of the reservoir. The walls are of stone, lined with 4 ins. of brick. A bed of concrete 9 ins. thick covers the bottom of the reservoir and extends beneath the walls. Ordinarily good construction would demand that this concrete should be thickened beneath the walls, to prevent cracking at the inner toe, but the soil here may be such as to render this unnecessary. Further dimensions of the walls and the nature and slope of the embankments and natural earth are shown in the section.

The gate-house is located at one of the corners of the reservoir, just outside the end wall. The bottom of the reservoir slopes slightly toward this end, being 1 ft. lower than at the center. The walls of the gate-house, and of the reservoir at this point, are on 2 ft. of concrete. The gate-house has brick walls 16 ins. thick. It is divided into two compartments, and presents no unusual features, except the floor from which the gates are worked. This floor is slightly above the reservoir wall and is formed by placing gratings on four 4 × 2¾ × ¼-in. I beams spaced 2 ft. 6 2-5 ins. on centers. To the top of each beam a bar of iron 1 in. sq. is fastened by means of ¾-in. screw bolts, with flush heads, the bolts being 2 ft. apart. Upon the beams, and separated at the ends by the bars, are the gratings forming the floor. These are in 20 sections, all 2 ft. 1¾ ins. wide, 12 being 2 ft. 5 2-5 and 8 being 2 ft. 5 ⅜ ins. long, resting at one end upon the wall of the gate-house. The grates are formed of 3-16 × 1-in. iron bars, placed 7-16 ins. apart, and held in position by three 5-16 in. iron bolts, one in the center and one 2 ins. from each end. The bars are kept in position by thimbles of ⅝-in. pipe, ⅜ ins. long, strung on the rods.

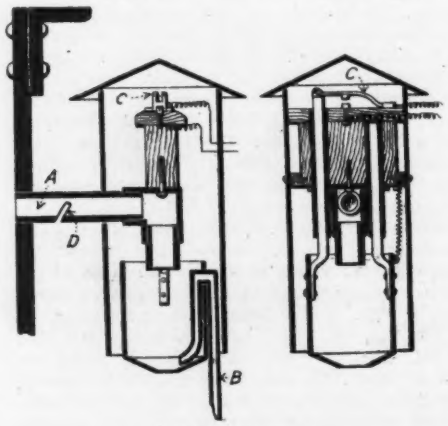
The reservoir was designed by Mr. M. M. TIDD, C. E., of Boston, Mass., and constructed under the direction of Mr. S. A. FORBES, of Ashland, Ky., these gentlemen being respectively designing and constructing engineers. Mr. J. J. NEWMAN, of Providence, R. I., built the reservoir under contract. Mr. J. M. GARDINER, of Ashland, is the president of the company, and we are indebted to him for the section and for the information from which the above was written.



SECTION THROUGH CENTER OF WATER-WORKS RESERVOIR, ASHLAND, KY. M. M. Tidd, Engineer.

A Non-Freezing High-Water Alarm.

The accompanying illustrations show a device in use in connection with the water-works at Brunswick, Me., to warn the engineer of the pumping station when the stand-pipe is filled. The device is fastened to the outside of the stand-pipe, at the high water line. It consists of a copper box attached to the end of a ½-in. pipe, as shown in the cut. The box is arranged so that, when filled with water from the stand-pipe through the pipe *A*, the weight of the water causes the box to be lowered until the spring key *C* is closed and a circuit formed through an electric wire extending to the pumping station. This rings an ordinary electric bell, and thus warns the engineer that the stand-pipe is full. The slot *D*, in the pipe, prevents water from running into the box until the stand-pipe is full enough to give the water sufficient velocity to leap across the slot and fill the box rapidly, thus preventing freezing. When the water slackens it again falls through the slot. The box is instantly emptied by the perforated bottom and discharging siphon *B*. The alarm was designed



High Water Alarm.

especially for use in the cold climate at Brunswick, Me., but it is evident that it will work equally well in any climate. It has been in use for some months, and has given an alarm promptly when the temperature was 20° below zero. The instrument was invented by Mr. G. H. SIMPSON, Superintendent of the Pejepscot Water Co., Brunswick, Me., who has patented it.

The Sanitary Service of Atlanta, Ga.

The last annual report of the Atlanta Board of Health contains some interesting facts regarding the work of sanitary inspectors and the removal of night soil and garbage. The work is done under the direction of the Board of Health, but is under the direct charge of Chief Sanitary Inspector T. E. VAIL, besides whom, the four district inspectors and the registrar of vital statistics, the Board employs 3 stablemen, 2 blacksmiths and 103 laborers.

The immediate necessity of providing a more extensive sewerage system is shown by the fact that

in 1890 there were removed from the city and buried in the city dumping ground 7,242 loads of night soil, averaging 30 bushels each, or a total of 217,260 bushels. This work was performed with the aid of 12 two-horse dumping wagons. The night soil is deposited in pits 4 ft. square and 16 ins. deep, and is covered with dry earth. As soon as possible grass or grain is sown upon the area thus treated and the soil is soon ready for more excrement. The number of surface privies within the sanitary limits of the city at the time of the report was 6,428. Outside the sanitary, but within the city limits, there are 3,532 additional surface privies, making a total of 9,960 within the city limits. The number of water closets within the sanitary limits is 2,910, and outside of the limits, but within the city, 84, making a total of 2,994 water closets against 9,960 open privies, or 77% of both closets and privies.

During the year 84,284 loads, or 1,685,680 bushels of garbage were collected and removed from the various sanitary districts. The garbage was collected from 9,350 premises, and removed by means of 44 one-horse dump carts. Inoffensive garbage is deposited by request, or with the permission of owners, on lots in or near the city, provided no objection is made by owners of abutting property. The remainder of the garbage is taken to the city dumping ground of 70 acres, located about three miles from the centre of the city and one mile from the city limits.

Night soil is removed at least once a week, and garbage from twice daily to twice weekly, as circumstances require. The garbage carts serve an average of 200 lots each, and the night soil wagons an average of 500 lots each. No vaults or cesspools are permitted within the city limits, and all surface privies within such limits are required by ordinance to be provided with watertight receptacles, in connection with which the abundant use of dry earth or fine coal ashes is made obligatory. It is intended to displace the above method of removing night soil by water carriage as rapidly as possible.

In addition to the work described the sanitary inspectors have supervision of the slaughter houses and dairies which supply the city; of street cleaning, flushing sewers and of plumbing. The chief inspector made an average of three visits during the year, to each of 1,202 jobs of plumbing. The four inspectors served 10,434 notices to abate nuisances of various kinds. The total expenses of the Board of Health in 1890 were $51,692, of which $1,000 was paid in salaries to the board of five members, $32,470 as salaries and wages to the inspectors and other employees, $4,015 for horses and mules and $9,373 for stock feed. The balance was made up of sundries.

A sanitary tax of $3 each was assessed upon 8,782 lots, 108 lots being exempt, making a total of $26,346, or over one-half the expenses of the whole health board. The remainder of the expense was met from a general appropriation.

The Stand-Pipe Failure at Defiance, O.

As noted last week a 22 × 140-ft. stand-pipe burst at Defiance, O., March 29. Through the courtesy of Mr. M. W. STEINBERGER, City Engineer, we are enabled to present the following particulars:

The stand-pipe was made of steel plate, diminishing in thickness from ⅝-in. at the bottom to ¼-in. at the top. It rested on a stone foundation 40 ft. in diameter and 15 ft. deep, to which it was anchored by eight 2-in. bolts. It had a "duck's-foot" central connection. Just before the break the pressure gage in the pumping station, near the stand-pipe, showed 139 ft. of water. Mr. STEINBERGER states that the material seemed to be first-class.

In a letter describing the occurrence, published in the *Engineering Record* of March 7, Superintendent S. M. STEVENS says that on a previous morning, when the pumps were started, there being 60 ft. of water in the stand-pipe, a large quantity of ice was thrown 10 ft. above the top of the pipe, and that "at the same time the pipe contracted and broke 10 ft. from the bottom." The nature of this break is not stated, nor is there any information regarding its repairs. The stand-pipe, however, has been in use since, so the break could not have been a large one. Mr. STEINBERGER states that at the time of the break (but without specifying which break) there was ice in the pipe 3 ft. thick.

From the above it would appear as if the bursting of the stand-pipe is attributable to the weakness caused by the strain which it received when the ice was thrown above its top. Also, that this first accident resulted from the pressure on the water, and possibly compression of air below the ice in the pipe, and from the falling of the ice and water back into the pipe, after it had been thrown up, these causes together producing a dynamic strain far in excess of the normal pressure on the pipe.

The continued use of the pipe after the first accident has a careless look, to say the least, unless there are some extenuating circumstances not reported.

Statistics Showing the Progress and Prospects of Railway Construction in the States East of Chicago.

(WITH MAP NO. 32.)

CANADA.

ONTARIO AND EASTERN PROVINCES.—Existing Roads.

Baie des Chaleurs.—Partly graded, Cascapedia, P. Q., to Paspebiac, P. Q., 40 miles.

1. *Brockville, Westport & Sault Ste. Marie.*—Surveyed, Westport, Ont., to Palmer Rapids, Ont., 80 miles.

2. *Canadian Pacific.*—Surveyed, Harvey, N. B., to Salisbury, N. S., 113 miles. Projected, Toronto, Ont., to Woodstock, Ont., 90 miles. Branch to Niagara Falls, Ont., 40 miles.

3. *Central Ontario.*—Projected, Coehill, Ont., to Sudbury, Ont., 210 miles.

Central Ry. of New Brunswick.—Projected, Doaktown, N. B., to Chipman, N. B., 30 miles; Norton, N. B., to St. John, N. B., 35 miles.

4. *Grand Trunk.*—Under construction, Blackwell, Ont., to Sarnia, Ont., 6 miles; Waterloo, Ont., to Elmira, Ont., 10 miles. Surveyed, Edmundston, N. B., to Berry's Mills, N. B., 180 miles.

Great Eastern.—Partly graded, St. Francis, P. Q., to Nicolet, P. Q., 15 miles. Surveyed, St. Gregorie, P. Q., to Chaudière Junction, P. Q., 67 miles.

Great Northern.—Track laid in 1890, New Glasgow to Cadottes, P. Q., 9 miles. Under construction, Cadettes, P. Q., to Montcalm, P. Q.; St. Andrews to La Chute, P. Q., 7 miles.

Intercolonial.—Track laid in 1890, North Sidney, N. S., to Sidney Junction, N. S., 5 miles.

5. *Kingston & Pembroke.*—Projected, Renfrew, Ont., to Eganville, Ont., 23 miles; Renfrew to Portage du Fort, Ont., 12 miles; Sharbot Lake, Ont., to Appleton, Ont., 45 miles.

Lake Temiscamingue.—Track laid in 1890, between Long Sault and Mattawa, Ont., 10 miles.

Lower Laurentian.—Track laid in 1890, end of track east, 10 miles. Partly graded, between St. Tite, P. Q., and Rivière à Perre, P. Q., 24 miles.

6. *Montreal & Ottawa.*—Track laid in 1890, Hudson to Regaud, 8 miles. Under survey, Regaud, Ont., to Ottawa Ont., 75 miles. Projected, Rockland Junction to Rockland, Ont., 2.5 miles; Hawkesbury to Vauclick Hill, Ont., 7 miles. Chief Engineer, J. M. Shanley, Hudson, Ont.

7. *Niagara Central.*—Projected, St. Catherines, Ont., to Toronto, Ont., 57 miles.

Nova Scotia Midland.—Under construction, New Glasgow, N. S., to Whitehaven, N. S., 60 miles. President, Herbert Richmond, 52 Broadway, New York City; Chief Engineer, G. Rodman Price, Springville, N. S.

8. *Ottawa & Gatineau Valley.*—Track laid in 1890, Hull Junction, Ont., north 10 miles. Track laid since Jan. 1, 1891, end track to La Peche, 9 miles. Under construction, La Peche to 30-mile post, 11 miles. Chief Engineer, W. D. Harris, 14 Metcalf St., Ottawa, Ont.

9. *Pontiac Pacific Junction.*—Projected, Black River to Pembroke, Ont., 14 miles. Chief Engineer, W. D. Harris, 14 Metcalf St., Ottawa, Ont.

Quebec Central.—Under survey, Tring Station, P. Q., to Lake Megantic, P. Q., 40 miles.

Stewiacke Valley & Lansdown.—Under construction, Brookfield, N. S., to Middle Stewiacke, N. S., 10 miles. Located, Middle Stewiacke to Lansdown, N. S., 27 miles. Surveyed, Brookfield to Newport Station, N. S., 50 miles. Chief Engineer, L. H. Buck, Upper Stewiacke, N. S.

Tobique Valley.—Track laid in 1890, end of track toward Plaster Rock, N. S., 3.3 miles. Located, end of track to Plaster Rock, N. S., 29.7 miles. Chief Engineer, L. H. B. Miles, Upper Andover, N. B.

Toronto Belt Line.—Under contract, belt line railway at Toronto, Ont., 8.5 miles. President, E. D. Edgar; Chief Engineer, H. Curry; both of Toronto, Ont.

Western Counties.—Track laid in 1890, Annapolis, N. S., to Smith's Cove, N. S., 16 miles.

Projects and Surveys.

Annapolis & Atlantic.—Projected, Annapolis, N. S., to Liverpool, N. S., with branch to Caledonia, N. S., 130 miles. President, Robert Hervey, Brockville, Ont.

10. *Bracebridge Colonization.*—Projected, Bracebridge, Ont., to Bayaville, Ont., 11 miles.

11. *Cobourg, Northumberland & Pacific.*—Surveyed, Cobourg, Ont., to Central Ontario Junction, 40 miles. President, Robert Mulholland; Chief Engineer, H K. Wicksteed; both of Cobourg, Ont.

Hants Central.—Projected, Windsor to Truro, N. S., 50 miles.

12. *Irondale, Bancroft & Ottawa.*—Surveyed, Irondale, Ont., to Bancroft, Ont., 40 miles. President, Henry S. Howland; Vice-President, Chas. J. Pasey, Irondale, Ont.

13. *Ottawa, Arnprior & Parry Sound.*—Projected, Ottowa, Ont., to Parry Sound, Ont., 40 miles.

14. *Peterboro, Sudbury & Sault Ste. Marie.*—Projected, Peterbury, Ont., to Sudbury, Ont., 235 miles. E. H. D. Hall, Peterboro, Ont.

15. *Toronto, Hamilton & Buffalo.*—Surveyed, Toronto, Ont., to Welland Junction, Ont., 77.5 miles. Chief Engineer, E. B. Wingate, Hamilton, Ont.

Total.—Track laid in 1890, 71.3 miles. Track laid since Jan 1, 1891, 9 miles. In process of construction, 200 miles. Surveyed or under survey, 888 miles. Projects of some promise, 1,032 miles.

MAINE.—Existing Roads.

16. *Kennebec Central.*—Track laid in 1890, Randolph to Togus, 5 miles.

17. *Phillips & Rangeley.*—Track laid in 1890, Phillips toward Rangeley, 24 miles. Graded, end of track to Rangeley, 4 miles. Secretary, F. E. Timberlake, Phillips.

Portland & Rochester.—Track laid in 1890, in city of Portland, 0.75 miles.

18. *Portland & Rumford Falls.*—Surveyed, Gilbertville to Rumford Falls, 14.4 miles.

19. *Sebasticook & Moosehead Lake.*—Under survey, Hartland to Athens, 10 miles.

20. *Somerset.*—Track laid in 1890, Salon to Bingham, 8 miles.

Projects and Surveys.

Bangor & Aroostook.—Projected, Brownesville to Van Buren, 175 miles. President, A. A. Burleigh, Houlton.

21. *Bath, Small Point & Popham.*—Projected, Bath to Popham Beach, 15 miles. Peter O. Vickery, Augusta; Herbert G. Foster, Waterville.

22. *Boothbay Harbor.*—Located, Boothbay Harbor to Penobscot Shore Line R. R., 13 miles. C. H. Fisher, Boothbay Harbor.

23. *Castine & Bangor.*—Projected, Castine to Bangor, 37.7 miles. President, Jos. Adams, Bangor.

24. *Farmington & Gardiner.*—Projected, Farmington to Gardiner, 35 miles.

25. *Georges Valley.*—Projected, Warren to Union Common, 8 miles.

26. *Penobscot Central.*—Located, Bangor to Milo, 40 miles. T. P. Batchelder, Kenduskeag.

27. *Rockland, Rockport & Camden.*—Projected, Rockland to Camden, 8.5 miles. President, W. J. Cobb, Rockland.

28. *Skowhegan & Norridgewock.*—Surveyed, Skowhegan to Norridgewock, 5.5 miles. Chief Engineer, Frederick Danforth, Gardiner.

Zig Zag.—Projected, seaside to harbor side of Peak's Island, near Portland, Me., 1.5 miles. Chief Engineer, E. C. Jordan, Portland.

Total.—Track laid in 1890, 37.75 miles. In process of construction 4 miles. Surveyed or under survey, 83 miles. Projects of same promise, 281 miles.

NEW HAMPSHIRE.—Existing Roads.

29. *Concord & Montreal.*—Track laid in 1890, Franklin to Tilton, 4.93 miles. Under construction, North Wear to Henniker, 6 miles. Surveyed, Barnstead to Gilmanton, 6.5 miles. Projected, Jefferson Hill to Jefferson Meadows, 3 miles.

30. *Maine Central.*—Track laid in 1890, Quebec Junction to Vermont line, 20.14 miles.

31. *Portsmouth & Concord.*—Surveyed, Greenland to Epping, 32 miles.

32. *Whitefield & Jefferson.*—Surveyed, Jefferson to Berlin, 15 miles.

Projects and Surveys.

Moosilauke.—Surveyed, Warren to Moosilauke Mountain, 9.5 miles. President, John H. Pearson, Concord.

Total.—Track laid in 1890, 25.07 miles. In process of construction, 6 miles. Surveyed or under survey, 44 miles. Projects of some promise, 3 miles.

VERMONT.—Existing Roads.

33. *Barre.*—Surveyed, East Barre to quarries, 1.25 miles.

34. *Bristol.*—Partly graded, Fairhaven to Bristol, 7 miles. President, Josh. J. Ridley; Chief Engineer, J. M. Fitch; both of Bristol.

35. *Central Vermont.*—Projected, Waterbury to Stowe, 10 miles.

36. *Clarendon & Pittsford.*—Track laid in 1890, Center Rutland to Rutland, 2 miles. Surveyed, Proctor to Brandon, 13 miles.

37. *Derrfield River.*—Projected, Readsboro to Wilmington, 14 miles.

38. *Maine Central.*—Track laid in 1890, North Stratford to New Hampshire line, 12.26 miles.

Total.—Track laid in 1890, 14.26 miles. In process of construction, 7 miles. Surveyed or under survey, 14 miles. Projects of some promise, 46 miles.

MASSACHUSETTS.—Existing Roads.

38. *Boston & Maine.*—Surveyed, Stoneham Center to Fells, 3 miles.

39. *Grafton & Upton.*—Track laid in 1890, Hopedale to Milford, 1.75 miles.

40. *Old Colony.*—Track laid in 1890, Attleboro to Walpole, 12.85 miles. Under construction, Walpole to Norwood, 4.16 miles. Surveyed, Norwood to Dedham, 6 miles.

Projects and Surveys.

41. *Plymouth & Bournedale.*—Surveyed, Plymouth to Bournedale, 22 miles.

42. *Plymouth & Middleboro.*—Surveyed, Plymouth to Middleboro, 16 miles. President, J. D. Shumway, Plymouth.

Total.—Track laid in 1890, 14.6 miles. In process of construction, 4 miles. Surveyed, or under survey, 47 miles.

RHODE ISLAND.—Existing Roads.

43. *New York & New England.*—Surveyed, Cumberland Mills to Providence, 7 miles.

44. *Providence & Springfield.*—Surveyed, Pascoag to East Thompson, 7 miles. Under survey, Primrose to Woonsocket, 4.5 miles.

45. *Woonsocket & Pascoag.*—Track laid in 1890, Woonsocket to Nasonville, 6 miles. Track laid since Jan. 1, 1891, Nasonville to Harrisville, 4 miles.

Total.—Track laid in 1890, 6 miles. Track laid since Jan. 1, 1891, 4 miles. Surveyed or under survey, 13 miles.

CONNECTICUT.—Projects and Surveys.

46. *Westerly & Jewett City.*—Surveyed, Westerly, R. I., to Jewett City, 25 miles. H. C. Chamberlain, Westerly, R. I.

NEW YORK.—Existing Roads.

Allegheny & Kinsua.—Track laid in 1890, Pennsylvania line to Tagus, 2 miles; branch line, 6 miles.

47. *Brookfield.*—Located, Brookfield to North Brookfield, 7 miles. President, Wm. Stanbro, Brookfield.

48. ***Carthage & Adirondack.***—Projected, end of track to Big Tupper Lake, 30 miles.

49. ***Chateaugay.***—Surveyed, Saranac Lake to Lake Placid, 10 miles.

50. ***Cooperstown & Charlotte Valley.***—Under construction, West Davenport to Davenport Center, 3 miles.

51. ***Delaware & Hudson Canal Co.***—Ticonderoga R. R.—Track laid in 1890, at Ticonderoga, 2.23 miles. Under construction, spur to mills, 0.33 miles. Adirondack R. R.—Projected, North Creek to Long Lake, 42 miles.

Dunderberg Spiral.—Graded, gravity railway at Mt. Dunderberg, 15 miles.

52. ***Dutchess County.***—Partly graded, Poughkeepsie to Hopewell, 12 miles.

53. ***Elmira, Cortland & Northern.***—Surveyed, Camden to Watertown, 60 miles.

54. ***Herkimer, Newport & Poland.***—Surveyed, Poland to Jocks Lake, 30 miles.

55. ***Hudson Suspension Bridge & New England.***—Surveyed, Turner's Station to Connecticut line, 40 miles. President, Edward W. Serrall, 38 Wall St., New York City.

56. ***Kanona & Prattsburg.***—Projected, Prattsburg to Geneva, 48 miles.

57. ***Kinderhook & Hudson.***—Track laid in 1890, Niverville to Hudson, 18.1 miles.

58. ***Lake Champlain & Moriah.***—Located, branch to mines near Elizabethtown, 2 miles.

59. ***Lake Shore & Michigan Southern.***—Under contract, Silver Creek to Dunkirk, 8.5 miles.

60. ***Lehigh Valley.***—Geneva & Van Ettenville R. R.—Under construction, Geneva to Van Ettenville, 57 miles. Buffalo & Geneva R. R.—Under construction, Geneva to Buffalo, 98 miles.

61. ***Little Falls & Dolgeville.***—Under contract, Little Falls to Dolgeville, 12 miles. Alfred Dolge, Dolgeville.

62. ***New York, Ontario & Western.***—Track laid in 1890, Hancock to Delaware River, 2.93 miles.

63. ***Northern Adirondack.***—Track laid in 1890, Paul Smith's to Tupper Lake, 22 miles.

64. ***Orange County.***—Track laid in 1890, Burnside to Maybrook Junction, 1.3 miles.

65. ***Rome, Watertown & Ogdensburg.***—Surveyed, Buffalo to Suspension Bridge, 25 miles.

66. ***Utica & Delaware.***—Partly graded, Bloomville to Oneonta, 22 miles.

67. ***Utica & Unadilla Valley.***—Partly graded, and track to New Berlin, 20 miles. A. C. Couch, 45 Broadway, New York City.

68. ***Wellsville, Coudersport & Pine Creek.***—Track laid in 1890, Genesee to Wellsville, 10.45 miles.

Projects and Surveys.

69. ***Adirondack & St. Lawrence.***—Surveyed, Valleyfield to Malone, 30 miles. President, Morton S. Parmlee, Malone.

Buffalo Dock & Connecting.—Located at Buffalo, N. Y., 7 miles. Chief Engineer, Geo. A. Ricker; Secretary, E. Van Etten; both of Buffalo.

70. ***Croton Valley.***—Croton Point to Connecticut line, 25 miles. F. Knowland, 48 Wall St., New York City.

71. ***Erie & Central New York.***—Surveyed, Cortland to Norwich, 35 miles. Fred Thomas, Cortland.

72. ***Fort Plain & Richfield Springs.***—Projected, Fort Plain to Richfield Springs, 20 miles. President, Wm. Clark, Fort Plain.

73. ***Lockport & Northern.***—Projected, Lockport to New Fane Station, 10 miles. President, William Spaulding, Lockport.

74. ***Neversink Valley.***—Projected, Fallsbury to Neversink, 10 miles. President, William B. Royce, Middleton.

75. ***Oneonta & Richfield Springs.***—Projected, Oneonta to Richfield Springs, 32 miles. President, A. C. Couch, 35 Broadway, New York City.

76. ***Poughkeepsie & Hudson.***—Projected, near Poughkeepsie to Boston & Albany R. R., 41 miles. President, J. V. Clark, Syracuse; Chief Engineer, E. H. Burlingame, 477 Broad st., Providence, R. I.

77. ***Rome & Carthage.***—Surveyed, Rome to Carthage, 56 miles. President, Jas. C. Smith, Rome.

78. ***Roundout Valley.***—Surveyed, Smithville to Kingston, 40 miles. President, Isaac N. Cox, Ellenville.

79. ***Saratoga, Johnstown & Western.***—Surveyed, Gloversville to Saratoga, 75 miles. Alfred Dolge, Dolgeville.

80. ***Seneca County.***—Projected, near Geneva to Seneca Falls, 10 miles. President, Jas. H. Gould, Seneca Falls.

81. ***Troy & New England.***—Projected, Troy to Lebanon Valley R. R., 35 miles. President, Walter P. Warren; Secretary, Wm. B. Thompson, both of Troy.

82. ***Washington County.***—Projected, Greenwich to Rutland, Vt., 56 miles.

Total.—Track laid in 1890, 65 miles. In process of construction, 248 miles. Surveyed, or under survey, 422 miles. Projects of some promise, 312 miles.

NEW JERSEY.—Existing Roads.

83 ***Brigantine Beach.***—Track laid in 1890, end of track to Brigantine Beach, 1.5 miles.

84. ***Delaware, Lackawanna & Western.***—Track laid in 1890. Bernardsville to Gladstone, 7.4 miles.

85. ***Lake Hopatcong.***—Under construction. Great Notch to Caldwell, 5 miles.

86. ***Lehigh Valley.***—Track laid in 1890. Newark to Roselle, 6.75 miles. Projected in Jersey City, 5 miles.

86 ***Pennsylvania.***—Track laid in 1890. New Lisbon, Brown's Mills, 1.78 miles. Under survey, Sea Isle City to Avalon, 4 miles.

87 ***Pennsylvania, Poughkeepsie & Boston.***—Surveyed, Swartswood to Hainesburg, 18.5 miles.

88. ***Philadelphia & Reading.***—Track laid in 1890. Mount Ephraim to Chew's Landing, 3.4 miles. Under contract, Bound Brook to New York Harbor, 19 miles.

89. ***Philadelphia & Seashore.***—Track laid in 1890. Winslow Junction to Tuckahoe, 25 miles. Partly graded. Tuckahoe to Sea Isle City, 10 miles.

90. ***Raritan River.***—Track laid in 1890, Sayreville Junction to Sayreville, 2 miles. Partly graded, New Brunswick to Bound Brook, 7 miles.

91. ***Rockaway Valley.***—Under construction, Peapack to Mendham, 6 miles. Surveyed, Mendham to Morristown, 8 miles.

Projects and Surveys.

92. ***Trenton & Atlantic.***—Projected, Trenton to Point Pleasant, 42.5 miles. Chief Engineer, C. C. Vermeule, 71 Broadway, New York City.

Total.—Track laid in 1890, 47.83 miles. In process of construction, 47 miles. Surveyed, or under survey, 31 miles. Projects of some promise, 48 miles.

DELAWARE.—Projects and Surveys.

93. ***Laurel & Roaring Point.***—Projected, Laurel to Tyaskin, Md., 25 miles.

MARYLAND. Existing Roads.

94. ***Baltimore & Drum Point.***—Partly graded. Baltimore to Drum Point, 82 miles. Surveyed, Conway's to Washington, 20 miles. Chief Engineer, Nicholas Goldsborough, 10 South Broad St., Baltimore.

95. ***Baltimore & Eastern Shore.***—Track laid in 1890. Easton to Salisbury, 42 miles.

Baltimore Belt.—Under construction, in city of Baltimore, 7 miles. Chief Engineer, Samuel Rea, Baltimore.

96. ***Confluence & Oakland.***—Surveyed, Manor Lands to Oakland, 15 miles. President, J. Bayard Henry, 742 Drexel Building, Philadelphia, Pa.

97. ***Deer Creek & Susquehanna.***—Projected, Bel Air to Havre de Grace, 25 miles. President, Geo. M. Jewett, Glenville.

98. ***Gunpowder Valley.***—Under contract, Hoffman to Rockdale, 5 miles. President, G. W. S. Hoffman, 11 South Gay St., Baltimore.

99. ***Washington City & Point Lookout.***—Projected, Mechanicsville to Point Lookout, 45 miles.

100. ***Western Maryland.***—Surveyed, Arlington to Colgate Creek, 8 miles.

Projects and Surveys.

101. ***Frederick & Monocacy Valley.***—Surveyed, Catoctin Furnace to Frederick, 13 miles. C. L. Hartsock, Frederick.

102. ***Jarrettsville.***—Projected, Sparks Station to Jarrettsville, 9 miles.

103. ***Easton & Northern.***—Projected, Easton to Chestertown, 35 miles. Chief Engineer, Chas. Goldsborough, Easton.

Total.—Track laid in 1890, 42 miles. In process of construction, 98 miles. Surveyed or under survey, 63 miles. Projects of some promise, 213 miles.

PENNSYLVANIA.—Existing Roads.

Allegheny & Kinzua.—Track laid in 1890, Gilbert's to New York line, 6 miles; Morrison's to Kinzua Valley, 2.25 miles; branch lines, 0.75 mile.

104. ***Altoona & Wapsononock.***—Track laid in 1890, Altoona to Logan, 5 miles. Under construction, Logan to Fallen Timber, 10 miles. President, T. G. Patterson, Altoona.

105. ***Beaver & Ellwood.***—Track laid in 1890, Ellwood Junction to Ellwood City, 3.5 miles.

106. ***Clarion River.***—Track laid in 1890, starting point to Owoga, 6 miles. Under construction, end of track to Hallton, 6 miles. Chief Engineer B. E. Wellendorf, Ridgeway.

107. ***Coudersport & Port Allegheny.***—Track laid in 1890, Coudersport to Sweden Valley, 5 miles. Surveyed, Sweden Valley to Ansonia, 33 miles.

108. ***Cumberland Valley.***—Surveyed, Fort Loudon to Mt. Dallas, 46 miles.

109. ***Delaware River & Lancaster.***—Track laid in 1890, St. Peters to French Creek Junction, 12 miles. Surveyed, St. Peter's to Lancaster, 33 miles.

Delaware, Susquehanna & Schuylkill.—Track laid in 1890, Drifton toward Gowen, 6.1 miles. Under construction between end of track and Gowen, with branches, 29.4 miles. Chief Engineer, Edgar Kudlich, Drifton.

Diamond Valley.—Track laid in 1890, Neff's Mills to Mooresville, 0.7 mile.

East Broad Top.—Track laid in 1890, on Shade Gap Branch, 1.5 miles.

110 ***Easton & Northern.***—Track laid in 1890, end of track to Easton, 8 miles.

111. ***Emmittsburg.***—Surveyed, Emmittsburg to Gettysburg, 11 miles.

112. ***Falls Creek.***—Track laid in 1890, Falls Creek to London mines, 3 miles.

113. ***Gettysburg & Chambersburg.***—Surveyed, Conococheague to Greafenburg, 10 miles. Chief Engineer, Samuel Culbertson, Chambersburg.

114. ***Johnsonburg & Bradford.***—Partly graded, Johnsonburg to Bradford, 35 miles. Chief Engineer, J. M. Floesch, Erie.

115. ***Lackawanna & Montrose.***—Partly graded, Montrose to Montrose Station, 10 miles. Surveyed, Montrose to Riverside, 14 miles.

116. ***Lancaster, Oxford & Southern.***—Surveyed, Quarryville to White Rock, 9 miles; Oxford to Singerly, Md., 14 miles. Chief Engineer, S. C. Slaymaker, Lancaster.

60. ***Lehigh Valley.***—Track laid in 1890, Pottsville to Schuylkill, 34 miles; Berwice to Lopez, 4 miles.

117. ***Middletown & Hummelstown.***—Track laid in 1890, Swatara Cave to Hummelstown, 1.25 miles.

118. ***Mahoning Valley.***—Track laid in 1890, 3 miles to Punxsutawney, 2 miles.

119. ***Newport & Sherman's Valley.***—Track laid in 1890, Newport to Loysville, 16 miles. Under construction, Loysville west, 5 miles. President, David Gring; Chief Engineer, A. P. W. Johnson; both of Newport.

120. ***New York, Lake Erie & Western.***—Surveyed, Carbondale to Honesdale, 14 miles.

62. ***New York, Ontario & Western.***—Track laid in 1890, Delaware River to Scranton, 51.12 miles.

86. ***Pennsylvania.***—Track laid in 1890, New Holland to Lancaster, 9.81 miles; Ednie Branch, 0.34 mile; Banion Branch, 2.19 miles; Butler Branch, 8.33 miles; Radebaugh Branch, 7.7 miles; Kendrick Branch, 0.7 mile; Ohio Connecting, 2.5 miles. Track laid since Jan. 1, 1891, McKeesport Bessemer Branch, 5 miles. Graded, Morrisville to Downington, 52 miles.—Turtle Creek Valley R. R. Partly graded. Stewart's to Murrysville, 7 miles. Projected, Murrysville to Saltsburg, 15 miles. Under construction, Palmer to Trangers, 5 miles; South Fork Branch, 5 miles. Located, Hecla to Mt. Pleasant, 3 miles. Projected, Cresson to Laurel Lick Creek, 65 miles.

121. ***Pennsylvania, Lehigh & Eastern.***—Surveyed, Port Jervis to Tomhicken, 100 miles. President, Joseph Poole, New York City.

87. ***Pennsylvania, Poughkeepsie & Boston.***—Surveyed, Statington to Harrisburg, 101 miles.

122. ***Perry County.***—Projected, New Bloomfield to Landisburg, 9.5 miles; branch to Logesville, 2.5 miles.

83. ***Philadelphia & Reading.***—Track laid in 1890, Hartsville to New Hope, 16 miles. Under construction, Bowmansdale to Harrisburg, 8.75 miles; Philadelphia Terminal R. R., 4 miles.

123. ***Pittsburgh & Western.***—Track laid in 1890, North Sewickley to Rock Point, 3.5 miles.

124. ***Pittsburgh, Shenango & Lake Erie.***—Track laid in 1890, Osgood to Dixonburg, 20 miles. Graded, Dixonburg to Girard, 26 miles.

125. ***Reginaldsville & Falls Creek.***—Projected, Reynoldsville to Adrian, 10 miles.

126. ***Schuylkill & Lehigh Valley.***—Surveyed, Bowman's Station to Tremont, 50 miles.

Sinnemahoning Valley.—Track laid in 1890, cut-off, 2 miles.

127. ***Titusville, Cambridge & Lake Erie.***—Track laid in 1890, Titusville to tannery, 1.5 miles. Partly graded, Titusville to Erie, 50 miles.

100. ***Western Maryland.***—Surveyed, Thomasville to Bowmansdae, 20 miles; Porter's Station to York, 15 miles.

128. ***Western New York & Pennsylvania.***—Located, New Castle to Oil City, 43 miles.

129. ***Wilkesbarre & Western.***—Track laid in 1890. Millsville to Rohrsburg, 6 miles. Under construction, Rohrsburg to Orangeville, 7 miles. Surveyed, Orangeville to Wapwallopen, 12 miles.

130. ***Williamsport & Binghamton.***—Projected, Williamsport to Dushore, 45 miles.

Projects and Surveys.

131. ***Homer & Susquehanna.***—Under survey, Homer City to Cherry-Tree, 20 miles. President, J. M. Guthrie, Indiana.

132. ***Kettle Creek.***—Projected, Westport to Trout Run, 14 miles. President, Edgar Munson, Williamsport.

133. ***Mt. Carmel & Natalie.***—Projected, Mt. Carmel to Natalie, 6 miles.

134. ***Neville Island.***—Projected, Pittsburg to Coroopolis, 14 miles.

135. ***New York, Philadelphia & Chicago.***—Surveyed, Franklin to Clearfield, 90 miles. President, Chas. Miller; Chief Engineer, Geo. C. Hamilton; both of Franklin.

136. ***Pennsylvania Midland.***—Projected, Stroudsburg to Scranton, 50 miles. Secretary, S. B. Mott, Scranton.

137. ***Pittsburg & Moon River.***—Surveyed, Groveton to Bennington, 6 miles. Engineers, Walker and Davison, Pittsburg.

138. ***Pittsburg, Cannonsburg & State Line.***—Projected, Pittsburg to Wheeling, W. Va., 63 miles. A. B. Paul, Pittsburg.

139. ***Reading & Southwestern.***—Projected, Reading to Mohrsville, 5 miles.

140. ***Saltsburg & West Lebanon.***—Surveyed, Saltsburg to West Lebanon, 10 miles.

141. ***Shoustown & Clinton.***—Projected, Shoustown to Clinton, 10 miles.

142. ***Southern Central.***—Surveyed, Sunbury to Dauphin, 45 miles. G. D. Snyder, Dauphin.

Uniontown & Lick Run.—Projected, Masontown to Confluence & Oakland R. R., 1.5 miles. President, John Boyle, Masontown.

Total.—Track laid in 1890, 230.74. Track laid since Jan. 1, 1891, 5 miles. In process of construction, 284 miles. Surveyed or under survey, 692 miles. Projects of some promise, 288 miles.

OHIO.—Existing Roads.

143. ***Baltimore & Ohio.***—Akron & Chicago Junction R. R.—Track laid in 1890, 30 miles. Track laid since Jan. 1, 1891, 20 miles. Graded, 19 miles.

144. ***Cleveland & Marietta.***—Surveyed, Kimbalton to Loudonville, 68 miles.

Cleveland Belt.—Under contract, at Cleveland, 7 miles.

145. ***Cleveland, Lorain & Wheeling.***—Projected, Medina to Cleveland, 25 miles.

146. ***Cleveland, Wooster & Western.***—Under contract, Lodi to Wooster, 20 miles.

147. ***Columbus, Hocking Valley & Toledo.***—Track laid in 1890, Wallbridge to Rockwell, 2 miles.

148. ***Columbus, Lima & Milwaukee.***—Partly graded, Lima to Defiance, 40 miles. Located, Lima to Columbus, 80 miles. Projected, Columbus to Floodwoods, 60 miles; Defiance to Allegan, Mich., 145 miles. President, B. C. Faurot, Lima.

149. ***Columbus, Shawnee & Hocking.***—Track laid in 1890, Saltillo to Sayers, 11.1 miles.

150. ***Delaware & Eastern.***—Partly graded, Delaware to Centerburg, 22 miles. D. Paul, Centerburg.

Findlay Belt.—Under construction, around city of Findlay, 20 miles.

151. ***Findlay, Fort Wayne & Western.***—Partly graded, Glandorf to Fort Wayne, 55 miles.

152. ***Lancaster & Hamden.***—Track laid in 1890, Tarlton to Laurelton, 5 miles. Track laid since Jan. 1, 1891, Laurelton to Bloomingville, 15 miles. Under construction, Bloomingville to Wellston, 22 miles. C. & M. V. Junction to Columbus, 20 miles; Tarlton to Hadley, 26 miles. Surveyed, Wellston to Ceredo, 50 miles; Locust Grove to McArthur, 10 miles. E. P. Buell & Co., Tarlton.

Michigan Central.—Track laid in 1890, North Toledo to West Toledo, 3.84 miles.

153. ***Middletown & Cincinnati.***—Track laid in 1890, Middletown southeast, 3 miles. Track laid since Jan. 1, 1891, end of track south, 4 miles. Graded, end track to King's Station, 7 miles. Chief Engineer, W. D. Burke, 41 Pike Building, Cincinnati.

154. ***Pittsburg, Akron & Western.***—Track laid in 1890, Akron to Carey, 109 miles. Projected, Akron to Magadore, 8 miles.

155. ***Pittsburg, Ohio Valley & Cincinnati.***—Track laid since Jan. 1, 1891, 3 miles. Under construction, Powhattan to Bellaire, 15 miles. Surveyed, Powhattan to Marietta, 60 miles. President, A. J. Warner, Marietta.

156. ***Port Clinton Short Line.***—Partly graded, Port Clinton to Tremont, 20 miles. President, E. H. Brennon, Port Clinton.

157. ***Sandusky, Ashland & Coshocton.***—Located, Sandusky to Ashland, 50 miles.

158. ***Toledo & Ohio Central.***—Track laid in 1890, Broadwell to Newton, 15 miles.

159. ***Toledo, Columbus & Cincinnati.***—Track laid since Jan. 1, 1891, Kenton to Ridgeway, 9.4 miles. Surveyed, Ridgeway to Columbus, 59.85 miles. Chief Engineer, J. C. Williams, Kenton.

160. ***Toledo, Findlay & Springfield.***—Track laid in 1890, Bowling Green to North Baltimore, 5 miles.

161. ***Wheeling & Lake Erie.***—Track laid in 1890, Laurelton to Stubenville, 17.3 miles; Warrenton to Martin's Ferry, 7.2 miles.

Gainesville Terminal.—Track laid in 1890 at Gainesville, 1.5 miles. Under construction, 4.26 miles.

Projects and Surveys.

162. ***Hocking & Western.***—Projected. Athens to London, 90 miles. Vice-President, G. R. Carr, Columbus.

163. ***Massillon & Little Beaver.***—Projected, Massillon to Little Beaver, 60 miles.

164. ***Painesville & Phalanx.***—Projected, Painesville to Phalnx, 50 miles.

165. ***Sandusky, Columbus, Lake Erie & Southern.***—Located, Sandusky to Columbus, 108 miles. President, John McKelroy; Chief Engineer, Chas. A. Judson, both of Sandusky.

166. ***Springfield & South Charleston.***—Projected, Springfield to South Charleston, 10 miles.

167. ***Tiffen & Fremont.***—Located. Marblehead to Upper Sandusky, 75 miles,

Total.—Track laid in 1890, 209.94 miles. Track laid since June 1, 1891, 61.4 miles. In process of construction, 57. miles. Projects of near promise, 33 miles.

INDIANA.—Existing Roads.

168. ***Chicago & Eastern Illinois.***—Under survey, Terre Haute to Louisville, Ky., 125 miles.

169. ***Cincinnati, Wabash & Michigan.***—Track laid in 1890, Anderson to Rushville, 38.54 miles.

170. ***Cleveland, Cincinnati, Chicago & St. Louis.***—Located, Harrison, O., to Richmond, 39 miles. Projected, Louisville to Aurora, 100 miles.

171. ***Evansville & Terre Haute.***—Track laid in 1890, Sand Creek, east, 17.5 miles; Hymena to Jackson's Hill, 3.7 miles. Projected, Jasper to Washington, 30 miles.

172. ***Fort Wayne, Terre Haute & Southwestern.***—Track laid since Jan. 1, 1891, Carbon Hill to Mansfield, 8 miles. Under construction, Mansfield to Bainbridge, 22 miles.

173. ***Lake Shore & Michigan Southern.***—Surveyed, Chesterton to Fayette, O., 150 miles.

174. ***Louisville, Evansville & St. Louis.***—Projected, Marengo to Trinity Springs, 40 miles.

175. ***Louisville, New Albany & Chicago.***—Projected, Evansville to French Lick Springs, 65 miles.

176. ***Midland (Indiana).***—Track laid in 1890, Brown's Valley to Vandalia Junction, 4.1 miles.

New Albany Belt & Terminal.—Track laid in 1890, in city of New Albany, 2 miles.

177. ***Ohio & Mississippi.***—Track laid in 1890, Riverdale to Bedford, 6.5 miles. Under construction, Tanyard Creek quarries to Mitchell Hollow quarries, 1.44 miles.

178. ***St. Louis, Vandalia & Terre Haute.***—Projected, Indianapolis to Frankfort, 40 miles.

179. ***Wabash.***—Track laid in 1890, Peru to Chili, 9.6 miles. Projected, Butler to Hammond, 165 miles; Covington to Brazil, 50 miles.

Projects and Surveys.

180. ***Rochester, Rensselaer & St. Louis.***—Projected. Rochester to Gilman, Ill., 100 miles. President, John K. Lee, St. Louis, Mo. Chief Engineer, Burr P. Noland, Winamac.

181. ***Terre Haute & Mississippi River.***—Projected, Terre Haute to Chester, Ill., 180 miles. President, H. Holman, Terre Haute.

Total.—Track laid in 1890, 81.94 miles. Track laid since Jan. 1, 1891, 8 miles. In process of construction, 43.44 miles. Surveyed, or under survey, 289 miles. Projects of some promise, 395 miles.

MICHIGAN.—Existing Roads.

182. ***Alba, East Jordan & Frederick Short Line.***—Track laid between Frederick and East Jordan, 20 miles.

183. ***Central Michigan.***—Projected, Rogers to Lowell, 200 miles; Hastings to Garrett, Ind., 90 miles.

184. ***Chicago & West Michigan.***—Track laid in 1890, Between Baldwin and Traverse City, 37 miles; Holland to Ottawa Beach, 7.1 miles. Located, Traverse City to Charlivoix, 62 miles.

185. ***Chicago, Kalamazoo & Saginaw.***—Projected, Woodbury to St. Johns, 35 miles; Kalamazoo to Marcellus, 25 miles.

186. ***Cincinnati, Saginaw & Mackinaw.***—Track laid in 1890, West Bay City to Oa-at-ka Beach, 5.66 miles.

187. ***Detroit, Charlivoix & Escanaba.***—Located, Mackinaw to Harrison, 170 miles. Chief Engineer, S. N. Beardsley, Charlevoix.

188. ***Duluth, South Shore & Atlantic.***—Projected, Palmer to Gladstone, 35 miles.

189. ***Escanaba, Iron Mt. & Western.***—Track laid in 1890, Escanaba to Iron Mt., 53 miles. Graded, Iron Mt. to Florence, Wis., 15 miles.

190. ***Flint & Pere Marquette.***—Projected Novi to Detroit, 25 miles.

191. ***Grand Rapids & Indiana.***—Track laid in 1890, Jennings Springs Junction to Lake City, 9.63 miles. Surveyed, Ludington to Vincent, 33 miles.

192. ***Manistee & Grand Rapids.***—Track laid in 1890, Oak Park to Sauble River, 9.83 miles. Under construction, Sauble River to South Branch Sauble River, 3 miles; Oak Park to Manistee River, 5 miles. Surveyed, South Branch Sauble River to Luther, 19 miles. Projected, Luther to Grand Rapids, 67 miles. Chief Engineer, E. W. Meunscher, Manistee.

193. ***Manistee & Northeastern.***—Track laid in 1890, Nessen City to Lake Ann, 17.41 miles. Under construction, Lake Ann to Traverse City, 25 miles.

194. ***Toledo, Ann Arbor & North Michigan.***—Surveyed, Mt. Pleasant to Big Rapids, 40 miles.

Projects and Surveys.

Baraga & Watersmeet.—Projected, Baraga to Watersmeet, 40 miles. President, C. A. Newcomb; Vice-President, Jas. W. Alston, both of Baraga.

195. ***Grand Rapids, Chicago & St. Louis.***—Surveyed, Grand Rapids to Benton Harbor, 80 miles. President, W. D. Salford; Vice-President, Chas. E. Temple, both of Grand Rapids.

196. ***Holland & South Shore.***—Projected, Holland to Macatoway, 5 miles President, W. H. Buck; Vice-President, G. J. Collen, both of Holland.

Iron Range & Huron.—Located, Aroon to Champion, 35 miles. President, C. H. Buhle; Chief Engineer, Milo Davis, both of Detroit.

197. ***South Lyon & Northern.***—Projected, Lulands to Flint, 45 miles.

Total.—Track laid in 1890, 159.64. In process of construction, 38 miles. Surveyed, or under survey, 439 miles. Projects of some promise, 652 miles.

VIRGINIA.—Existing Roads.

Abingdon Coal & Iron.—Under construction, Abingdon to Damascus, 15 miles.

Atlantic & Danville.—Track laid in 1890, Bellfield to Hitchcocks, 8.14 miles; Mayo to near Milton, N. C., 27 miles; Savedge to Alcotts mills, 6 miles; Buffalo Junction to Buffalo Lithia Springs, 4 miles. Danville & East Tennessee R. R.—Under construction, Bristol, Tenn., to Damascus, 27 miles. Under survey, Damascus to Danville, 148 miles. Chief Engineer, T. W. M. Draper, Norfolk.

198. ***Chesapeake & Ohio.***—Track laid in 1890, branch to Ritch Patch mines, 6 miles; between Eagle Rock and New Castle, 5 miles. Track laid since Jan. 1, 1891, between Eagle Rock and New Castle, 20 miles. Under construction, Covington to Hot Springs, 24 miles.

199. ***Farmville & Powhatan.***—Track laid in 1890, Sunnyside to Farmville, 24 miles. Located, Farmville to Hampden Sidney College, 7 miles. Projected, Hampden Sidney College to Brook Neal, 30 miles; Cumberland to Appomatox, 50 miles.

Louisville & Nashville.—Track laid in 1890, Cumberland Gap northeast, 30 miles. Track laid since Jan. 1, 1891, end of track to Big Stone Gap, 40 miles. Located, Big Stone Gap up Callahan's Creek, 4.5 miles.

Lynchburgh & Durham.—Track laid in 1890, Boston to North Carolina line, 12 miles.

200. ***Norfolk & Western.***—Track laid in 1890, Honaker to Norton, 42.5 miles; Ivanhoe to Great Outburst, 16 miles; near Doran to mines, 1.2 miles; Richlands to mines, 4.16 miles; Washer to Bettie Baker, 6.23 miles. Under construction, Great Outburst to North Carolina line, 20 miles. Projected, Front Royal to Washington, 70 miles.

201. ***Orange & Keysville.***—Located, Orange to Farmville, 70 miles. President, John Goodwin, Baltimore.

Petersburg & Asylum.—Under construction, Petersburg to Matoaca, 0.75 miles.

202. ***Richmond & Chesapeake.***—Projected, Richmond to Wicomico, 50 miles.

Richmond & Petersburg.—Track laid in 1890, James River to Clopta, 5 miles.

203. ***Richmond & Tidewater Coal.***—Track laid in 1890. Coalfield to Tomahawk, 5 miles.

Richmond, Fredericksburg & Potomac.—Track laid in 1890, Arca to James River, 3 miles.

204. ***Roanoke & Southern.***—Under construction, North Carolina line to Roanoke, 60 miles.

South Atlantic & Ohio.—Track laid in 1890, Natural Tunnel to Big Stone Gap, 21 miles.

205. ***Staunton & West Augusta.***—Surveyed, Staunton to coal fields, 25 miles.

Projects and Surveys.

206. ***Bedford & James River.***—Surveyed, Bedford City to James River, 20 miles. Secretary, W. S. McKenney, Bedford City.

207. ***Blacksburg.***—Projected, Blacksburg to Roanoke, 32 miles. President, J. F. Christian, Roanoke; Secretary, W. H. Graham, Blacksburg.

208. ***Charlottesville & Southern.***—Projected, Charlottesville to James River, 24 miles. President, R. P. Valentine, Charlottesville.

209. ***Fincastle & Troutville.***—Surveyed, Fincastle to Troutville, 6.75 miles. President, E. B. Simmons, Fincastle. Chief Engineer, E. Grover, Iron Gate.

Norfolk & Portsmouth Belt.—Under survey, belt line around cities of Norfolk and Portsmouth, 10 miles.

Staunton Development Co.—Under construction, line to mines, 2.5 miles. Chief Engineer, C. R. French, Staunton.

Virginia & Kentucky.—Surveyed, Danville to Kentucky line, 210 miles. President, David S. Pierce, Wytheville.

Total.—Track laid in 1890, 226.23 miles. Track laid since Jan. 1, 1891, 60 miles. In process of construction, 148 miles. Surveyed or under survey, 522 miles. Projects of some promise, 203 miles.

WEST VIRGINIA.—Existing Roads.

143. ***Baltimore & Ohio.***—Partly graded. Morgantown to Uniontown, Pa., 33 miles.

198. ***Chesapeake & Ohio.***—Track laid in 1890, Coalburg to Cabin Creek, 15 miles.

210. ***Huntington & Big Sandy.***—Track laid in 1890, Huntington to Kenova, 5 miles. Under construction, end of track to Big Sandy River, 7 miles.

211. ***Kanawha.***—Track laid in 1890, Fairfield to Acme, 9.5 miles.

212. ***Monongahela River.***—Track laid in 1890, Shinnston to Clarksburg, 15 miles.

200. ***Norfolk & Western.***—Track laid since Jan. 1, 1891, on Elkhorn Extension, 20 miles. Under construction between Elkhorn and Ironton, O., 175 miles.

213. ***Ohio River.***—Track laid since Jan. 1, 1891, Ravenswood east, 10 miles. Under construction, end of track to Spencer, 23 miles.

100. ***Western Maryland.***—Under construction, Williamsport, Md., to Cherry Run, 14.2 miles.

214. ***West Virginia & Pittsburg.***—Track laid in 1890, Buckhannon to Shelbyville, 25 miles; Weston to Barnesville, 26 miles. Track laid since Jan. 1, 1891, Barnesville to Flatwoods, 12 miles. Under construction, Flatwoods to Gauley River, 35 miles; Newton to Florence, 9.0 miles.

215. ***West Virginia Central & Pittsburg.***—Under construction, Elkins to Beverly, 7 miles; Elkins to Belington, 17 miles. Under survey, Beverly to Covington, Va., 103 miles. Projected, Cumberland to Williamsport, Md., 84 miles.

Projects and Surveys.

216. ***Bayard, Peterburg & Moorefield.***—Under survey, Bayard to Moorefield, 40 miles.

217. ***Berryville & Summit Point.***—Projected, Summit Point to Berryville, Va., 10 miles. C. B. Wilson, A. B. Thompson, both of Summit Point.

218. ***Bluefield & Princeton.***—Surveyed, Bluefield to Princeton, 10 miles. Chief Engineer, H. S. Lamble, Roanoke, Va.

219. ***Pennsboro, Harrisville & Ritchie Co.***—Projected, Ritchie C. H. to Glenville, 25 miles.

220. ***St. Albans & Coal River.***—Projected. St. Albans to Kentucky line, 60 miles. President, M. P. O'Herne; Chief Engineer, W. C. Reynolds, both of Charleston.

221. ***West Virginia & Kanawha.***—Projected, St. Albans up Coal River, 60 miles. Chas. A. Draper. Exchange Place, New York City.

Total.—Track laid in 1890, 95.5 miles. Track laid since Jan. 1, 1891, 32 miles. In process of construction, 282 miles. Surveyed, or under survey, 131 miles. Projects of some promise, 171 miles.

KENTUCKY.—Existing Roads.

198. ***Chesapeake & Ohio.***—Track laid in 1890, Stone City to quarries, 9 miles; Hawksnest to mines, 4 miles.

222. ***Kentucky Midland.***—Surveyed, Paris to Morgan Co. line, 70 miles.

223. ***Kentucky Union.***—Track laid in 1890, Kentucky River to near Jackson, 23 miles.

Kinniconick & Freestone.—Track laid in 1890, Kinniconick to quarries, 9 miles.

Knoxville, Cumberland Gap & Louisville.—Track laid in 1890, Cumberland Gap to Middlesborough, 13.75 miles.

Lexington Belt.—Track laid in 1890, at City of Lexington, 5 miles.

224. ***Louisville, St Louis & Texas.***—Track laid in 1890, end of track to Fordsville, 1.3 miles. Fisher's Junction to Falls of Rough, 4.4 miles.

225. ***Louisville Southern.***—Track laid in 1890, Versailles to Richmond, 39.86 miles. Under construction, Richmond to Irvine, 23.36 miles. Located, Irvine to Beattyville, 34.96 miles. Projected, Beattyville to West Virginia line, 85 miles.

Middlesborough Belt.—Track laid in 1890, belt around city of Middlesborough, with branches, 16.4 miles. Under construction, extensions of branches, 9.5 miles.

226. ***Ohio & Big Sandy.***—Surveyed, Louisa to Norfolk & Western R. R., 40 miles.

Owensboro, Falls of Rough & Green River.—Track laid in 1890. Fair Grounds to Louisville, St. Louis & Texas R. R., 0.5 miles.

Paducah, Tennessee & Alabama.—Track laid in 1890 Paducah to Tennessee line, 49.1 miles.

Projects and Surveys.

227. ***Bowling Green & Northern.***—Located, Bowling Green to Chesapeake, Ohio & Southwestern R. R., 50 miles. Secretary, M. H. Crump, Bowling Green.

Burkesville & Northeastern.—Surveyed, Burkesville to Horse Cave, 46 miles. President, W. F. Alexander; Chief Engineer, H. A. Quincy; both of Burkesville.

228. ***Charleston, Kentucky & Western.***—Projected, Newport to Cumberland Gap, 189 miles. President, A. Baum, Mt. Sterling.

229. ***Chicago, Evansville & Chattanooga.***—Surveyed, Evansville to Bowling Green, 90 miles. Projected, Bowling Green to Chattanooga, Tenn., 165 miles Chief Engineer, A. B. Fitch, Terre Haute, Ind.; J. E. Williams, Evansville, Ind.

Cumberland Gap & Mississippi Valley.—Projected, Columbus to Hopkinsville, 90 miles. President, Jos. F. Hoard; Secretary, Hunter Wood, both of Hopkinsville.

230. ***Cynthiana & Western.***—Projected, Georgetown to Maysville, 55 miles.

231. ***Kentucky & Cumberland.***—Surveyed, Frankfort to Sparta, Tenn., 140 miles.

232. ***Hartford & Fordsville.***—Surveyed, Hartford to Fordsville, 19 miles. President, T. J. Smith, Hartford.

233. ***Louisville Southeastern.***—Projected, Louisville to Smithville, 25 miles. President, W. B. Hoke, Louisville.

Paducah & Hickman.—Projected, Paducah to Hickman, 50 miles. Secretary, W. F. Paxton, Paducah.

Total.—Track laid in 1890, 185.31 miles. In process of construction, 32.86 miles. Survey, or under survey, 490 miles. Projects of same province, 525 miles.

PERSONALS.

Mr. THOMAS BROWN has been appointed Superintendent of Water-Works at Allegheny, Pa.

Messrs. GROVER & WILSON, of Omaha, Neb., have opened an office in the Board of Trade building, and will carry on a general engineering business.

Mr. H. H. BEDOLF has been appointed Division Engineer of the Northern Pacific R.R., between Hope and Portland, Ore., vice Mr. BOURKE, resigned.

Mr. JAMES H. WINDRIM, Supervising Architect, Treasury Department, Washington, D. C., has resigned. He has been appointed Director of Public Works at Philadelphia, Pa.

Col. J. H. AVERILL, Superintendent of the South Carolina Division of the Georgia Central R. R., has been appointed Grand Manager of the Charleston, Sumter & Northern R. R.

Mr. OSCAR SAABYE, M. Am. Soc. C. E., has resigned his position as Assistant Engineer of Maintenance of Way on the Roanoke division of the Norfolk & West-

ern R. R., and has entered into partnership with Mr. C. COLEMAN to carry on a general civil and mechanical engineering business at Roanoke, Va.

Mr. F. S. BURROWES, of Lancaster, Pa., Asst. U. S. Engineer for the district of Maine and New Hampshire, was married recently at Portland, Me., to Mrs. A. M. GOLDTHWAITE.

Mr. EDWARD CORKINGHAM has been appointed Superintendent of the Oregon division of the Union Pacific Ry., with office at Portland, Ore., vice Mr. A. H. CROCKER, resigned.

Director DAVID M. GREENE, for many years past the head of the Rennselaer Polytechnic Institute faculty, has notified the Board of Trustees of his intention to tender his resignation soon, stating that he signified this intention thus early in order to enable the vacancy to be properly filled. He has filled the position about 13 years and has also been a consulting expert engineer for various corporations, in which practice he will no doubt continue.

Prof. GREENE is now, we believe, in his 60th year. He graduated from the R. P. I. in 1850, and continued two years as an instructor at the Institute, when he went into the service of the State on the Erie Canal. From 1855 to 1861 he was professor of geodesy and topographical drawing at the Institute. In the spring of 1861 he was appointed third assistant engineer in the United States Navy, participating in a number of engagements. In September, 1862 he was ordered to the United States Naval Academy as instructor in steam engineering and three years to department duty at Washington. Later he became chief engineer of the West India Squadron. In 1869 he resigned and engaged in civil engineering practice till 1878, when he was appointed to the position which he is about to resign.

NEW PUBLICATIONS.

APRIL MAGAZINES.

The *Popular Science Monthly* contains several articles of especial interest. Perhaps the most so is "A Brief History of the Ohio River," which recounts the evidences that a great lake once existed, formed by an ice dam between Cincinnati and Louisville, which covered half of Ohio and much of western Pennsylvania and Kentucky. The old channel of the Ohio ran north of Cincinnati, by way of Dayton, O. Another article of special interest relates to a question which has been much discussed in these columns, "What keeps the Bicycler Upright?" by C. B. WARRING, the conclusion being that it is made possible by the fact that the motion of a body just beginning to fall is very slow, and that equilibrium is maintained by instinctive and unconscious slight turnings of the guiding wheel, by which the base is made to run under the body as it begins to fall, and so restores equilibrium. It is asserted, and no doubt with truth, that it is impossible to run a bicycle securely for any considerable distance after the guiding wheel has been locked fast; but the explanation does not seem entirely adequate, nevertheless, since it implies that with some apparatus to move the base of the wheel laterally, it would be as easy to keep it upright when standing as when moving. The phenomenon would seem to be largely influenced by the same causes which make it so easy for the youngest child to use a hoop and keep it upright.

The *Forum* contains a vigorous arraignment of the census by ROGER Q. MILLS, who advances some further strong grounds for questioning its accuracy, which we will not attempt to recount, but which have certainly still further strengthened our suspicion that there must be some serious errors of omission in that census. It is a curious illustration of how strong are the tendencies to political partianship in this country, that a pure question of fact like this should be regarded as one on which men are expected to and do take sides according to their political predeliction. One faithful subscriber has written us a letter complaining that we were "siding with the Democrats," and discussing political issues, because of the views we have expressed as a result of critical analysis of the census figures.

We are sorry to see in the same magazine an article, which in part at least, is unsound and weak from that usually sound and vigorous writer, Prof. A. T. HADLEY, who discusses "Railway Passenger Rates." His conclusion is that there is little or no room for further reduction of passenger rates, because we give so much more for the money than the few countries which now have lower rates than ours. Most of the facts narrated by Prof. HADLEY are true and untwisted, as almost goes without saying; but some of his conclusions from his facts, or apart from facts, are woefully unsound. For instance, he remarks with an air of ending the whole matter: "If any one will go into a station in one of our large cities at a busy hour of the day, and ask whether double the traffic could be handled without great increase of expense, he will at once see the absurdity of the question." If Prof. HADLEY will pardon us, not only is "anyone's" opinion worse than worthless under these conditions and on such a subject, but his own opinion is likewise. Things which look absurd to the casual bystander, or even to the careful student of railway statistics, are not therefore really so. As a matter of fact, there is not a railway terminus in this country which cannot be arranged to handle double the traffic it now handles in the same area and yet do nothing unprecedented nor beyond what has been already done abroad, where it is not likely that the ultimate possibility has yet been reached. This same song has been sung unceasingly since the days when the traffic was not a quarter what it is to-day, and with quite as absolute a conviction as Prof. HADLEY'S. He is wrong as to the facts; and because of this and a few other like errors his whole argument is to be taken with many grains of salt.

The *Forum* also contains an excellent article on "The Flood Plane of Rivers," by W. J. MCGEE, and the *North American Review* one of interest at least, if a trifle biased, on "The West and the Railroads," by SIDNEY DILLON, President of the Union Pacific Railway.

The literary magazines contain unusually little of technical interest. Perhaps the most interesting is a striking article in the *Atlantic* on "Prehistoric Man on the Pacific Coast," by GEO. FREDERICK WRIGHT. Alaska, the Straits of Magellan, Argentine Republic and other outlying regions have several articles devoted to them, however, in the other magazines, some of them, apparently, for the main purpose of floating some fine illustrations.

—*Architectural Iron and Steel, and its Application in the Construction of Buildings.* With Specifications of Ironwork and Abstract of New York City Building Law, and Tables relating in Computations for Architectural Ironwork. By Mr. H. BIRKMIRE. New York: John Wiley & Sons, 8vo, pp. 201, of which 18 tables; about 200 cuts. $3.50.

This is another of the many American technical books issued nowadays, the bulk, weight and cost of which are needlessly increased. This volume weighs nearly 30 ozs. Henck's Fieldbook weighs 6 ozs., and contains much more matter. To make a closer parallel, a little English scientific book published by Longman's, BARRY'S "Railway Appliances," which is a model of typographical neatness and clearness, contains 294 pages of about as many words per page as the volume now in question, and weighs just 14 ozs. Had this work been published in similar style it would have been in every respect a handsomer, more useful and more readable book. Had it then been sold at $2.50 instead of $3.50 (which last is a pretty steep price for it although the book essays to fill a gap which many would be glad to stop with even a $5 or $10 bill) both author and publisher would have made more money, and the public would have been saved time, strength and money.

This fashion of padding out scientific books to unnatural bulk, after the fashion of the cheap subscription books, is getting to be a nuisance, not to say an insult, to the intelligence of the men who buy such books. We have determined to do what we can to put it down, by unsparingly exposing it in the case of every new book which reaches our table and thus offends. Did we believe that a change of practice meant any real loss of profit to the publishers, or especially to the authors, we might hesitate about doing this, for the authors of scientific books get none too great returns for their labor but we believe and know that it does not. Should it result in curtailing the sale of the books which thus offend, it will be but a just punishment for a needless offense. The publishers must be their own judges of whether it will or not. They may be assured that if we fail to note the offense in any instance it will be because we forgot it, or because the superlative merit of the book seemed to make comment on its form superfluous.

The present work is by no means one of such superlative merit. On the contrary it is rather thin. It is plainly not the product of that untiring labor which men put into books which are to be permanently useful and an honor to their name. Nevertheless, it is in a comparatively new and vacant field, and has some good and useful points. The strength of the book lies in its specifications as to minor details of iron construction, such as cast iron columns, iron stairways, doors, shutters, elevator inclosures, floor-lights and sky-lights, mail chutes, slides, gates, sidewalk elevators, skuttles, fire escapes, window guards, tanks and a few other such details. As to these the book will be handy of reference to many, though as to no one of them can it be said to be very complete. But on such a vital question in architectural iron construction as hollow clay flooring blocks, for example, there are just three pages, and of many of the more recent developments in this line we get no hint. It might be claimed that brick or terra-cotta flooring is not iron work, but in the chapter on floors, which is certainly a vital element in such construction, we have only four or five pages apart from the tables taken (and condensed so as to be hardly worth printing) from the various manufacturer's manuals, and even the accompanying text is much less complete than is to be found in some of those manuals. For instance, just seven lines are given to the fundamental question of the line load to be assumed, and not one word is said as to the present necessary practice in all very high buildings, of proportioning each floor to support the maximum assumed load, but proportioning the column supports of the load for a decrease of 5 %, more or less, on each floor below the top, so that the average live load assumed for all the stories together of a 20 story building becomes just one-half of the assumed maximum for each floor. Unless this be done the foundation computations become distorted beyond all reason, and on yielding ground such as Chicago has to contend with, for example, the settlement would certainly be unequal. There is not a word in this book, moreover, as to the modern iron foundations so much used in Chicago. The only information given as spacing of I-beams is a wretched little diagram on page 10, which if drawn to four or five times the scale, as is the original from which it is taken, would be useful, but as it is, is quite unfit for use.

In fact, as to the half of the volume which deals with the broad principles of iron construction the less said about it the better, because nothing good can be said about it. Pretty much all the matter in it is condensed from existing handbooks, and so condensed as to destroy its convenience and practical usefulness; nor do we anywhere find admission that all that is given on this head, and much more, can be found in admirable manuals which are distributed gratis. The instruction tendered on trusses and truss strains, for example, is contained on eight very open pages.

It is with no surprise that we turn to the back end of the volume, and find not even an apology for an index. Our rough and ready rule for judging of the quality of books by the index only is a pretty sure one.

—*Five Years at Panama.* The Trans-Isthmian Canal. By WOLFRED NELSON, M.D. New York: Belford Co. 12mo., pp. 287, numerous views, $1.50

The Isthmus of Panama has become a much less important part of the earth since the collapse of the Panama Canal Co. and the rise into prominence of the Nicaragua route. The world is now pretty well convinced that a canal cannot and will not be built there, and that it can and will be built via Nicaragua. Nevertheless, the little strip of land between Colon and Panama has for the last four centuries been the scene of great enterprises and of great events, while, as the scene of the great canal fiasco, it still has great interest to practical men, who wish to study the conditions on that canal as an index of the extent to which they may obtain or be avoided on the Nicaragua or other like enterprises. For this purpose there is not and could not well be a better aid than this volume. Those who still remember the flush days of the de Lesseps enterprise, when the press generally spoke of the enterprise very gingerly and with evident reluctance to throw cold water on it, will recall a series of Cassandra-like letters which appeared in the Montreal-*Gazette* and were frequently copied in this journal and elsewhere, tending to show that that enterprise was inwardly rotten and doomed to early and certain collapse. They were from the pen of a young Canadian physician who went to Panama just before work began in 1881 and remained until the beginning of the end had come. His letters, with various corrections and additions, and, of course, with many subtractions, have now been embodied in this volume, which is throughout bright and readable, and which is, in addition, a complete record of the whys and wherefores of the de Lesseps fiasco.

We do not propose to review the work in detail, not even the closing quarter of the work, in which the author has, with crushing force, contrasted the successive disingenuous and fraudulent statements by which the Panama Canal Co. succeeded in floating hundreds of millions of securities after its certain failure was looked for by all intelligent men. We told the substance of the story long ago, but never in such complete form as in this work, which makes it of great value for reference. That there is no real parallel between the Panama and Nicaragua enterprises, and that the disappointing results of the first are in no respect a proper augury of the fate of the second, every page of this work makes clear.

One certain basis of comparison, however, is afforded by the facts recordered in this work as to the Panama R. R Co. The Nicaragua company has just finished the construction of the first 10 miles of railway over the coast flats. It was built in about 6 mos., all told, by some 600 or 800 workmen, among whom there was a good deal of severe malarial sickness, as was unavoidable, but not one of whom (we believe we are correct in saying) died of the malarial fevers alone. Certainly very few died; nor was there more than one or two deaths, if any, from the bite of snakes. The total cost of this work, all told, apart from the rails, was a little over $20,000 per mile.

What were the facts as to the Panama R. R.? Work on it began in the fall of 1849. "The country was a howling wilderness, pestilential and death-dealing: the forests teemed with poisonous snakes and other equally unpleasant inhabitants. In some of the swamps the engineers failed to find bottom at 180 ft. It took nearly two years to complete some 23 miles of road. On Jan. 27, 1855 [5¼ years after work first began], the first locomotive crossed from ocean to ocean," a distance of only 47½ miles. It is a matter of historic record, we believe, that every tie on the road cost a life. At any rate that statement is true in substance. The total cost up to May, 1855, was $7,000,000, or $147,300 per mile average, and the first 23 miles must have cost nearly twice this average, or more than 10 to 15 times what corresponding work on the Nicaragua route has cost.

Surely here is a contrast which is impressive, if not decisive, and which goes far to discredit those would-be prophets who shake their heads and point to Panama whenever the Nicaragua project is mentioned. Our author does not take this view; he speaks very favorably of the Nicaragua route, which he has personally examined, though we infer that he still has fears which are but reasonable that the influx of a large working population may seriously change for the worse the sanitary conditions. It is quite certain that this will be the tendency, but on the other hand, sufficiently rigid policing ought to be able to prevent this, and certain other facts narrated in the volume before us go far to encourage the belief that the contrast which has so far existed will continue to the last. Besides the bad natural conditions at Panama, there is a frightful system of exhuming dead bodies by wholesale after 18 to 24 months' interment, regardless of what pestilential diseases they have died from. The details given of this practice are appalling, and as it has continued for centuries, it is probable that it may have had much to do with the pronounced pestilential tendency on the isthmus. This, at any rate, is the impression we derive from reading Dr. NELSON'S volume, which we can heartily commend to all those seeking information as to the subjects discussed in it.

—*Business Atlas and Shippers' Guide*, 1891. Containing Large Scale Maps of Canada, Mexico, Central America, Cuba and the Several States and Territories of the United States, with a Complete Reference Map of the World, Printed in Colors, Accompanied by a Ready Reference Index, Showing the Entire Railway System, Each Printed in Colors, the Express Company doing Business over Each Road, and Accurately Locating all Cities, Towns, Post Offices, Railway Stations, Villages, Counties, etc. Rand, McNally & Co., Chicago. Large 4to, pp. 334, 108 maps, $7.50.

The contents of this atlas are quite adequately set forth in the above title, and, as will be seen, are intended primarily for the use of shippers and business men. The maps are plain and clear, and are printed entirely in black and white, with light buff borders to emphasize the state and county boundary lines, all high coloring, the bane of so many works of this class, being entirely done away with. The reference index is very complete and is conveniently arranged with regard to the maps. Taken as a whole the work shows much attention to detail and accuracy, and is one which we can heartily recommend to persons desiring a reliable atlas at a comparatively small cost.

—*Dynamos and Electric Motors*, and all about them. By EDWARD TREVERT. Lynn, Mass: Bubier Pub. Co. 12mo, flex. cloth, pp. 96. 45 cuts, 50 cts.

The title of this little book, which appears to be a reprint of a series of articles, is decidedly broader than its contents, since it treats its subject in the most sketchy way, with a plentiful lack of those carefully compiled details and records which give to such works a permanent scientific value. Nevertheless, it will suffice to give the uninformed seeker after electrical knowledge a smattering of information on its subject in a readable way, and with but trifling demands on his powers of concentration.

—*Report of the Department of Public Works of Philadelphia for* 1890. Pamph., pp. 128.

The reports of the above department increase in value each year, because of the improved methods and increased economy of conducting the various bureaus, and because of the comparative statistics given, the latter sometimes extending over several years. In the present report, for instance, the operations of the gas works for 50 years are presented in tabular form. As is generally known the department is divided into six bureaus, each of which has a chief, as follows: Gas, highways, lighting, street cleaning, surveys and water. In addition the city has ice boats in charge of a superintendent. The work of each bureau is quite fully reviewed by the Director prior to the detailed reports of the several chiefs. Some of the most interesting matter in the report will be abstracted separately.

—*Annual Report of the Water Commissioners of Taunton, Mass., for* 1890. Pamph., pp. 67, map and large sheet of profiles.

This report contains a somewhat detailed discussion of the contamination and purification of water supplies, with especial reference to the present and prospective supply for Taunton. The problem of improving the water supply of Taunton is complicated owing, to the fact that the present supply is taken from infiltration galleries and driven wells, and thus is a combination of ground and surface water, each requiring different modes of purification. Owing to the lack of an efficient sewerage system a flow of water sufficient to prevent dead ends cannot be maintained, and even if sewers were provided the supply is not ample enough for this purpose, unless it be drawn from the river, which is now used only in case of emergency.

The report states that the futility of attempting to increase the present supply to any considerable extent has been demonstrated. Other sources are discussed, but all involve some method of purification or some means of preventing contamination from vegetable growth. One of the proposed sources of supply, Elder's Pond, and a route for a gravity pipe line from it to the pumping station, is shown by a map and by profiles. No plan is recommended for immediate adoption, owing to the present high rate of taxation and the need of expending money for a sewerage system. Awaiting the time for action, the commissioners propose to make a study of various kinds of filtration.

—*Annual Report of the New York State Engineer and Surveyor.* JOHN BOGART, State Engineer, Albany, N. Y. Paper; pp. 44.

This report is for the fiscal year ending Sept. 30, 1890, and gives particulars of the work done on the canals etc. The tests of cement used since 1887 show ranges in tensile strength of 30 to 246 lbs. per sq. in. after 7 days, and 73 to 365 lbs. after 28 days, with averages of 72.3 and 151.5 respectively. Tables are given of the results of surveys of the crest of the Niagara Falls, showing an average annual recession of 7.68 ins. for the American and 21 13 ins. for the Horseshoe Falls. In regard to the inspection of iron and steel bridges, it is suggested that provision should be made for an inspection by the State Engineer, or an expert acting under his supervision, of all plans and specifications for such bridges before contracts are let. The corps consists of the State Engineer and Surveyor and his deputy, 3 division engineers, 3 resident engineers, 8 assistant engineers, 10 levelers, 18 rodmen, 14 chainmen, 1 engineer in charge of work connected with the lands of the state, 3 clerks and 2 stenographers.

—*Annual Reports of Atlanta, Ga., for* 1890. R. M CLAYTON, City Engineer. W. G. RICHARDS, Superintendent of Water-Works. Pamph., pp. 380 and index.

In addition to the usual matter this volume contains reports by Mr. RUDOLPH HERING, C. E., on both sewerage and water supply. The report on the latter subject was made late in 1889. The report on a sewerage system for the city was made in December, 1890, and is separately abstracted. The report of the Board of Health contains some interesting and valuable matter regarding the removal of night soil and garbage, and the work of the sanitary inspectors. It also presents some analyses of water, both from the public supply and from wells.

SOCIETY PROCEEDINGS.

Rensselaer Society of Engineers—At the meeting at Troy, N. Y., on April 3, Mr. A. S. KIBBE, Assistant State Engineer, delivered a lecture on "The Recession of the Niagara Falls."

Engineers' Club of Cincinnati.—At the meeting on March 19 the question: "Will a cut of 5,000 cu. yds. make a fill of 5,000 cu. yds. after a haul of from 500 to 1,000 ft.?" was discussed at considerable length. The paper for the evening, by Mr. W. H. D. TOTTEN, comprised a description of the plants of the Edgar Thomson and the Homestead Steel Works at Pittsburgh.

Association of Engineers of Virginia.—This society has been organized recently at Roanoke, Va. President, Capt. J. H. Wingate, Roanoke; Vice Presidents, Prof. W. E. Anderson, of Blacksburg, and Mr. C. R. Boyd, of Wytheville; Secretary, H. W. Newby, Roanoke; Treasurer, J. R. Schick, Roanoke; Directors, W. W. Coe, C. C. Wentworth, C. Coleman, J. C. Rawn and W. M. Dunlap, of Roanoke; R. A. Marr, Lexington; John Graham, Jr., Norfolk; W. M. Thornton, University of Virginia.

Engineers' Club of Philadelphia.—At the regular meeting on March 21, President Wilfred Lewis in the chair, the secretary presented for Mr. Harry B. Hirsh, an illustrated description of an iron sewer template which had been used in the construction of a cement sewer. Mr. Strickland L. Kneass presented notes on the discharge of steam into the atmosphere through tubes of different shapes, with pressures from 30 to 120 lbs. per sq. in. The results showed that for all pressures above 25 lbs. the velocity of discharge at any given section of a correctly proportioned tube was practically constant; and that, under the same conditions, the flow of weight was almost directly proportional to the initial pressure. A simple formula, comparing very closely with observed results, was given for determining the weight of steam discharged per second from an orifice, in terms of the initial density of the fluid.

The Institution of Mechanical Engineers.

[FROM OUR LONDON CORRESPONDENT.]

The spring meeting of the Institution was held in London on March 19 and 20. There were only two papers down on the programme, the first being on "The Friction of a Pivot Bearing" and the second on "Recent Trials of Rock Drills." The former paper embodied the fourth report of the Research Committee on Frictionof the Institution. The bearing used for the experiments was 3 ins. in diameter. The bearing was pressed upward against the footstep by an oil press with a plunger, 6 ins. in diameter, which was a good but free fit in the cylinder for a length of 9 ins. A number of grooves were turned in the cylinder throughout its whole length. There was connected with the footstep a circular plate, which had a groove turned in its periphery. A small chain lay in the groove round a portion of the circumference, whence it led to a spring balance attached to the fixed frame of the apparatus. By these means the rotation of the plate stretched the spring balance, and the amount of the force tending to turn the plate was indicated. The upper end of the vertical shaft which carried the footstep had a piston fixed to it, and this piston revolved in a cylinder 6 ins. in diameter. The upper cylinder was connected to the lower by a pipe, so that whatever pressure there was in the lower cylinder pressing the bearing upward, there would be the same in the upper cylinder pressing the footstep downward. In this way the desired test pressure on the bearing was obtained. The results of the trials were embodied in a table, and were plotted on a diagram. We condense the following from the total results:

EXPERIMENTS ON THE FRICTION OF A PIVOT BEARING. STEEL FOOTSTEP ON MANGANESE BRONZE BEARING.

Speed. Revs. per min.	Load. Lbs. per sq. in.	Oil drops per min.	Friction. Total inch-lbs.	Friction. Coefficient.
50	20	20	2.77	0.0196
	80	30	10.25	0.0181
	120	36	18.72	0.0221
128	20	79	1.13	0.0080
	100	98	5.48	0.1077
	160	81	12.82	0.0113
194	20	196	1.44	0.0102
	100	200	3.13	0.0044
	150	168	7.69	0.0068
290	20	Continuous stream.	2.51	0.0178
	140	" "	4.51	0.0046
	160	200	5.03	0.0044
353	20	Continuous stream.	2.36	0.0167
	100	" "	4.09	0.0056
	160	" "	6.15	0.0054

The friction given is that of one face of the flat circular-bearing surfaces at either effective radius of the face—namely, one inch.

Similar experiments were tried with a white metal bearing when the coefficient of friction was approximately the same.

The lower coefficient of friction at the higher speeds is attributed to the more perfect lubrication. An additional set of experiments were made, the manganese bronze and white metal bearings both being tested for endurance at 128 revolutions per minute with no lubrication. The manganese bronze heated and seized with a load of 260 lbs. per sq. in. on one occasion, and with a load of 300 lbs. on another occasion. The white metal bearing under similar conditions heated and seized with a load of 240 lbs. per sq. in. Experiments were tried in the matter of lubrication, and it was found that a single diametrical groove afforded the best means of distributing the oil, and was decidedly superior to radial grooves. The diametrical groove approached very closely the oil bath arrangement of some former experiments of the committee. A discussion followed the reading of the report, but nothing of special interest was brought forward, excepting that one speaker pointed out that temperature records would throw some light on the subject. A higher temperature would diminish the viscosity of the oil. It may be stated, although the information was not contained in the paper, that the lubricant used was an ordinary mineral oil lubricant.

The paper on Rock Drills was by Messrs. Carbutt and Davey. Last year there was a mining exhibition at the Sydenham Crystal Palace, whereat a number of rock drills where shown. The exhibitors arranged a little sporting competition amongst themselves to see whose drill could first get through a lump of granite that another exhibitor was showing, and the authors of the paper were appointed umpires. It is a very difficult thing to arrange a satisfactory rock drill competition, and in the present case there seems to have been more than usual facilities for failure. As the competitors arranged the conditions of trial, and as these conditions represented in as small a manner as possible the conditions of actual work, we can only suppose makers of rock drills have a great deal to learn about the using of rock drills.

The following machines were in the competition: McCulloch's "Rio Tinto," Stephen's "Climax," the Bickle, the Ingersoll-Mayne, the Daw, Coles, and Hat horn's "Eclipse." These were the power drills. The hand drills were the Ingersoll, and Bromfield-Ingersoll. We do not feel inclined to give space to the details of the competition as set forth in the paper, for the reasons stated; in addition to which the meter used for measuring the air delivered was far from beyond question. In the discussion by which the reading was followed there was expressed the opinion that hand work was as cheap as power working, although the latter was naturally more rapid. The advocates of the power drill said that the users did not act to the best advantage, inasmuch as they did not work with sufficient pressure in using only 60 to 70 lbs. air pressure per square inch.

The summer meeting of the institution will be held in Liverpool during the last four or five days in July.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

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D. McN. Stauffer, A. M. Wellington.....Editors
Chas. W. Baker, E. E. R. Tratman, M. N. Baker, F. P. Burt, } Associate Editors
Geo. H. Frost.....Business Manager

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COMING TECHNICAL MEETINGS.

Engineers' Club of Duluth.—April 11. Secy., M. W. Lewis.
Engineers' Club of Kansas City.—April 13. Rooms, Baird Building. Secy., H. Goldmark.
Civil Engineers' Club of Cleveland.—April 14. Secy., A. H. Porter, 50 Euclid Ave.
Denver Society of Civil Engineers.—April 14, "Proper Use of Metal in Bridges." Secy., Geo. H. Angell.
Engineering Association of the South.—April 14. Secy., Chas. H. Lanpreth, Vanderbilt University, Nashville, Tenn.
Engineers' Club of St. Louis.—April 15. Secy., Arthur Thatcher, Room 813, Odd Fellows' building.
American Water-Works Association.—Annual meeting, April 14-17, Continental Hotel, Philadelphia. Secy., J. M. Diven, Elmira, N. Y.
American Society of Civil Engineers.—April 15. Annual meeting, May 20, at Lookout Mt., Tenn. Secy., Francis Collingwood, 127 E. 23d St., New York.
Engineers' Club of Cincinnati.—April 16. Secy., J. F. Wilson.
New York Railroad Club.—April 16. Rooms, Gilsey House. Secy., H. G. Prout.
Engineers' Club of Philadelphia.—April 18. Secy., Howard Murphy, 1122 Girard St.
Western Railway Club.—April 21. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery Bldg.
Engineers' Society of Western Pennsylvania.—April 21. Secy., S. M. Wickersham, Pittsburg, Pa.
Boston Society of Civil Engineers.—April 22. Secy., S. E. Tinkham.
Association of Civil Engineers of Dallas.—May 1. Secy., E. K. Smoot, 808 Commerce St.
Northwest Railroad Club.—May 2. Secy., H. P. Robinson, St. Paul, Minn.
Civil Engineers' Society of St. Paul.—May 4. Secy., C. L. Annan.
Western Society of Engineers.—May 6. Secy., J. W. Weston, 280 La Salle St., Chicago.
Engineers' Club of Minneapolis.—May 7. Rooms, Public Library Bldg. Secy., F. W. Cappelen.
Technical Society of the Pacific Coast.—May 8. Secy., O. von Geldern, 819 Market St., San Francisco.
Civil Engineers' Association of Kansas.—May 18. Secy., J. C. Herring, Wichita, Kan.
New England Railroad Club.—May 13. Secy., F. M. Curtis.
Northwestern Track and Bridge Association.—May 15. Secy., D. W. Meeker, St. Paul, Minn.

We give up considerable space in this issue to a letter describing another suggested solution of a problem which seems to have fascinated a good many engineers, from Zerah Colburn down, but in which as yet practically nothing has been accomplished, viz., the substitution for subaqueous tunnels of some form of bouyant subaqueous tubular bridge. Another suggested application of this same idea, worked out in somewhat more detail, was described and illustrated in our issue of Feb. 28, 1891. The publication of both of these articles was contrary to our general rule, which is to give up no space to the suggestion of untried novelties. But the particular problem to which both of these articles are devoted is one of such possible importance as to warrant such exception. It is undeniable that the difficulties which impede the construction of such floating tunnels are purely practical; theoretical difficulties there are none. Even the practical difficulties are as yet hypothetical, in the sense that they have not yet been affirmatively shown to be serious by the failure of attempts to overcome them. It is only recently that iron and steel has become so cheap, capital so abundant, engineering plant so perfect and quick transportation so imperative that such projects could have been reasonably undertaken. But the number of different localities where ready and cheap subaqueous transit for short distances is a great desideratum is now great, and under the other conditions of to-day we are unable to see why an enlargement of engineering resources by the successful construction of some floating subaqueous tunnel-bridge may not be hopefully looked for. The practical difficulties and dangers are beyond doubt great, and in a large measure unforeseeable, but that they are insuperable, or even more serious than many other difficulties which have been completely overcome, we cannot believe. To mention only one possibility: Long lines of water pipe have before now been pushed out over water from the shore, being made to float merely by a plank over the end, and then gently and securely lowered to the bottom by the admission of water. Why may not a larger tube, which is in effect a tunnel, be constructed and lowered upon previously prepared supports in the same way? In some respects it would be easier to do this with a large tube than a small one.

If the late tempest in a teapot over the fate of a few Italian cut-throats and assassins of the lowest class shall have two effects it will not have been in vain. It ought to lead to a more liberal policy in regard to our naval and coast defenses, and (what is still more important in the end) to a radical revision of the conditions on which we admit immigration. The wealth of the United States was assessed at nearly $50,000,000,000 in 1880 and had nearly tripled in 20 years. Its actual aggregate in 1891 is probably very near to twice the great sum named, of which $100,000,000 would be just a tenth of one per cent., and with this sum once appropriated to that special end, we could build a very respectable navy, which a much smaller yearly sum would maintain and keep our coast impregnable to attack by any power or combination of powers, in connection with other coast defenses. The confidence which Americans seem to have in mere latent strength as a sufficient protection may yet lead to an otherwise needless war, and a severe national humiliation. Americans do not seem able to realize that the sickliest pauper with a pistol in his hand is more than a match for a giant with money enough in his pocket to buy out an armory, if the latter is foolish enough to let the pauper "get the drop" on him.

Similarly, Americans seem as yet unable to realize the serious change which has taken place both in the quality of our immigration and the conditions controlling it. From the beginning of settlement until within a couple of decades ago "natural selection" was our sufficient safeguard against an objectionable class of immigration. It took considerable money, considerable endurance, considerable self-reliance and pluck to emigrate to the United States, and only those having these qualities did emigrate to it in considerable numbers. Latterly these conditions have all changed. It takes hardly any time or money, or endurance, to come over here. Employment at rates which seem high to European peasants is more easily obtained than ever, and, as a consequence, while the desirable class of immigration is coming here in greater volume than ever before, an undesirable and degraded class is coming here in hordes who never come before at all. From a purely material joint of view this class of immigrants is useful to us, as were the Chinese, but there is precisely the same objection to such immigration as there was and is to the immigration of Chinese, which an overwhelming majority of Americans now see was wisely checked. Even though we opened fewer mines and built fewer railways, the privilege of emigration to this country should be treated as a privilege, and accorded only to the decent, the intelligent and the law abiding, or at least to those who appear to be such.

A rather unusual controversy between architects, and not a very savory one, has arisen over the proposed new cathedral of St. John the Divine. It will be remembered that about two years ago, competitive plans for such a cathedral were invited, a select list of prominent architects being guaranteed in advance a small sum to cover the cost of their drawings, and the rest of mankind being invited to send in plans "on spec" if they chose to do so, for certain specified and very moderate premiums. The opportunity was one to stimulate the ambition of any architect, and when the time came for opening the plans it was found that 61 different designs had been tendered, out of which four plans were selected as particularly meritorious. In accordance with the terms of the contest, the authors of these four plans were requested to prepare more elaborate and detailed drawings, for a stated and moderate compensation, as a preliminary to a final selection. Of the four plans thus selected, only one, if we remember correctly, was by an architect who had been specially invited to compete, and of the three others, one was signed as by "Heins & La Farge, W. W. Kent," the first named being a firm of young architects practicing in this city, and the last named another young architect practicing here on his own account.

When the more detailed plans came to be opened according to program, they were found to be signed only "Heins & La Farge," and it was generally supposed that, for reasons satisfactory to himself, Mr. Kent had withdrawn from the special partnership. A few days later, however, the following letter from Mr. Kent was made public:

To the Rev. Dr. Morgan Dix, Chairman of the Building Committee of the Cathedral of St. John the Divine.

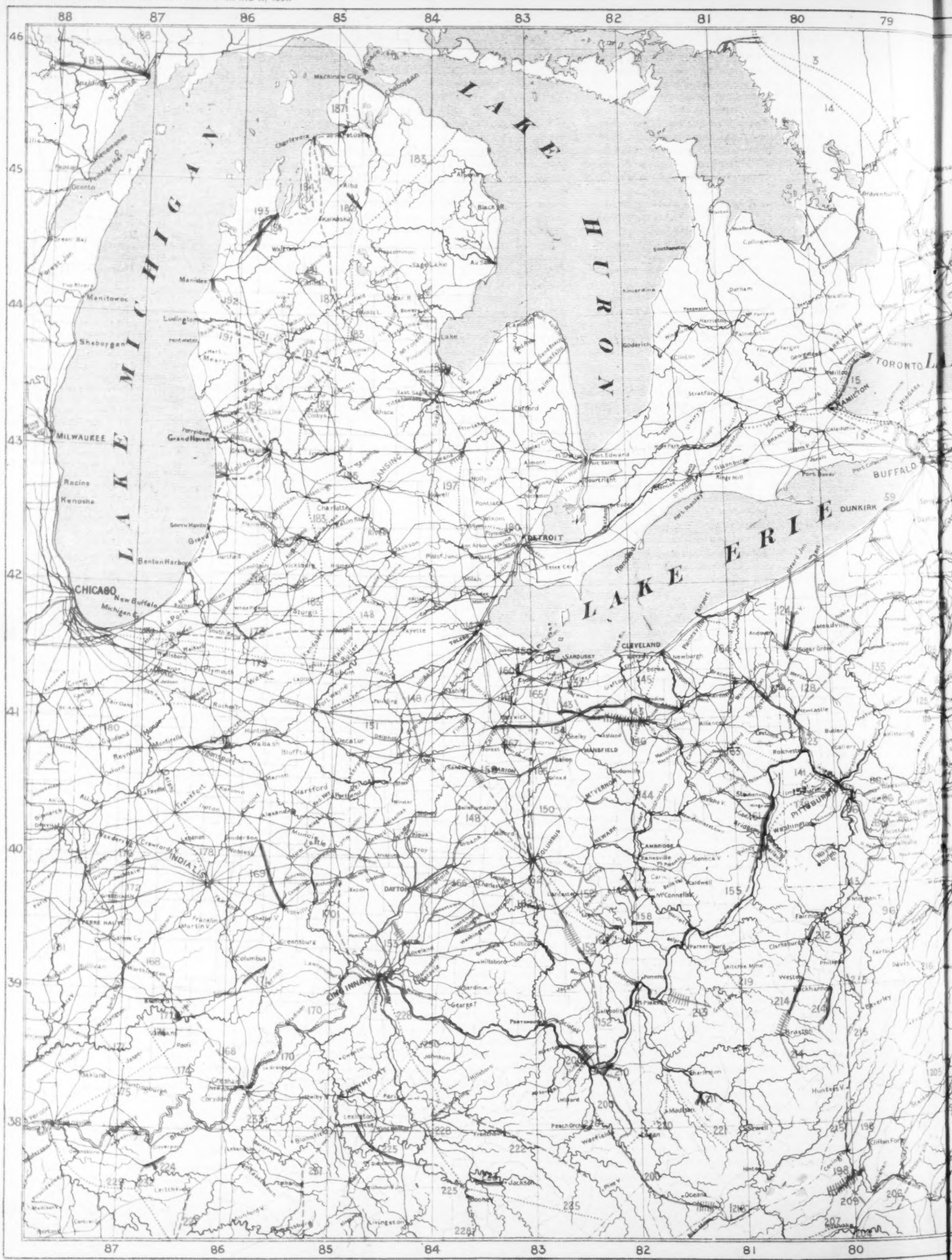
Dear Sir: I notice in the description appearing in some of the newspapers of the several plans for the proposed cathedral submitted for final competition that my name does not appear in connection with those of Messrs. Heins & La Farge appended to our joint designs.

To prevent any misunderstanding, I wish to say that my relations with those gentlemen remain in all respects the same as when the preliminary plans were submitted, namely, those of an equal partner in the enterprise.

Wishing to leave entirely unembarrassed any action the committee may take upon the plans, I simply wish to correct what appears to be a mistaken impression as to their origin and ownership. I have the honor to remain very respectfully yours, William Winthrop Kent.

To this letter no reply or denial has been attempted by Messrs. Heins & La Farge, so far as known.

We know nothing about the interior merits of this controversy. No one can but the three partners themselves. It may or may not be that some one or two members of the "triple alliance" did more than their share of the work, or did all of the really important work. It may still more probably be that some one or two members now think they did this or had that fact revealed to them as in a vision after their plans had been unexpectedly successful, and thus justify themselves for what is apparently an attempted "freeze-out." But the facts remain that they went into the competition jointly, for they signed the plans jointly, and that, after their joint plan had won success, two of these partners have without the consent of the third attempted to appropriate the entire credit to themselves, and have given them out to the public as by themselves alone. As such, the procedure is, from any point of view, a disgraceful one, and the offense has been aggravated since the publication of the letter by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Sheboygan
Green Bay
Escanaba
Menominee
Marinette
Oconto
Ludington
Grand Haven
Benton Harbor
New Buffalo
Michigan C.
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Petoskey
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Berlin
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Woodstock
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Tillsonburg
Simcoe
Port Dover
Port Colborne
BUFFALO
DUNKIRK
Niagara Falls
Welland
Port Dalhousie
St. Catharines
Thorold
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Port Stanley
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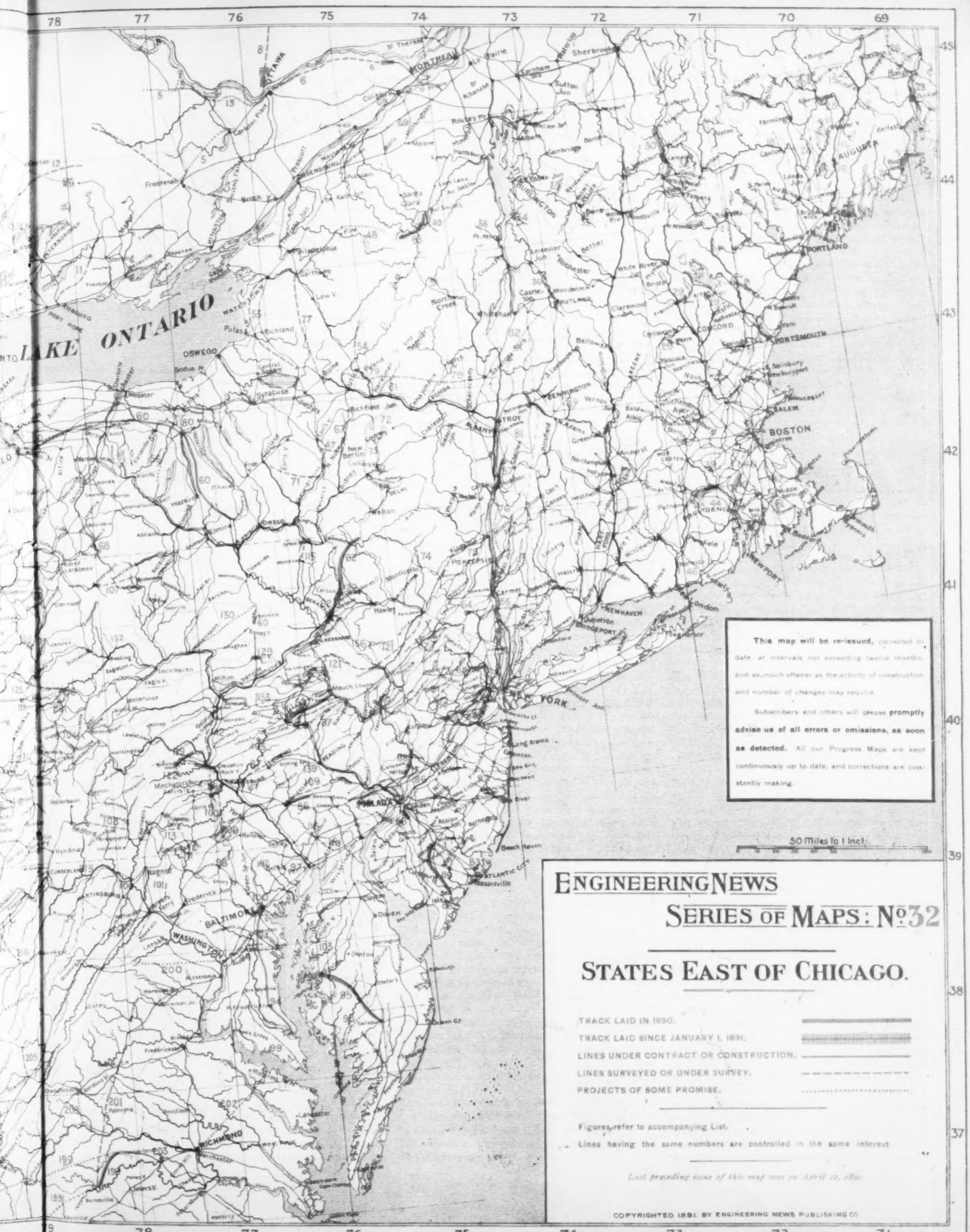

This map will be re-issued, corrected to date, at intervals not exceeding twelve months, and as much oftener as the activity of construction and number of changes may require.

Subscribers and others will please **promptly advise us of all errors or omissions, as soon as detected.** All our Progress Maps are kept continuously up to date, and corrections are constantly making.

ENGINEERING NEWS
SERIES OF MAPS: No. 32

STATES EAST OF CHICAGO.

TRACK LAID IN 1890.

TRACK LAID SINCE JANUARY 1, 1891.

LINES UNDER CONTRACT OR CONSTRUCTION.

LINES SURVEYED OR UNDER SURVEY.

PROJECTS OF SOME PROMISE.

Figures refer to accompanying List.

Lines having the same numbers are controlled in the same interest.

Last preceding issue of this map was on April 12, 1890.

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87	86	85	84	83	82	81	80

CHAS. HART & SONS LITH. 38 VESEY ST. N. Y.

rushing the plans into print as by "Heins & La Farge" only, without any intimation that a third architect had shared in their preparation, and without any delay to await the issue of the legal proceedings which, we are informed, have been begun. Even had Mr. KENT given a formal consent to the withdrawal of his name, the procedure would have been a suspicious one, for it is always possible for any two members of a partnership of three to gradually "freeze out" a third, or make it so disagreeable for him that he will "voluntarily" withdraw. It is hardly conceivable that a young architect who had had part in such a success would "voluntarily" withdraw, except under pressure of such a "freeze-out." But it now appears that there was not even the form of a prior withdrawal. The procedure is almost as silly as it is unfair, moreover, because it practically excludes the plans altogether from all chance in the competition. No one is likely to choose them with such a cloud upon their title, nor to wish those to become architects of a cathedral who are open to reasonable suspicion of gross unfairness. Taking the most favorable view possible of the circumstances, that Mr. KENT contributed little or nothing to the success of the plans, there was credit enough and to spare for all concerned in such a success; a mere suggestion, which added only one per cent. to the merit of the plan, may have added the decisive one per cent., which gave it the preference over the next best plan, and it is contrary to every generous instinct that he who was welcomed to a share in the struggle should not likewise be welcome to his share of the triumph.

A GENERAL INDEX TO ENGINEERING NEWS, extending from the first issue of Volume I., in 1874, to the end of Volume XXIV. (July–December, 1890), is now in press, and will be issued as soon as possible, in a separate small volume handsomely bound in cloth, which will be sold at $1. It will prove a valuable work of reference even for those whose files are not complete.

Railway Construction in the States East of Chicago.

We present with this number of ENGINEERING NEWS the fourth annual issue of our map and statistics showing the progress of railway construction in the states east of Chicago. The figures here given show that, while there has been a considerable decrease from the totals published with our last preceding map of this section, yet taken as a whole construction is quite active. The following table gives by states the mileage in the various stages of construction:

States.	Track laid. 1890.	Track laid. To date in 1891.	Under contract or construction.	Located or under survey.	Projects of some promise.
Maine. .	37.75	..	4	83	281
N H.....	25.04	..	6	44	3
Vt.....	14.26	..	7	14	46
Mass.....	14.6	..	4	47	..
R. I.....	6.	4.	..	19	..
Conn.....	....	..		25	..
N. Y.....	65 01	..	248	422	312
N. J.....	47.83	..	47	51	48
Del.....	....	..	..	..	10
Md.....	42.	..	98	63	213
Pa.....	230.74	5.	284	602	288
Ohio.....	209.94	61.4	267	577	333
Ind.....	81.94	8.	43	289	595
Mich.....	150.65	..	38	439	632
	934.82	78.4	1,066	2,845	2,781

Comparing these totals with those published with our last preceding map of this section, we have the following results at the two dates named:

	Track laid. Year previous.	Track laid. Portion of year to date.	Under construction.	Under survey.	Projected.
April 12, 1890.....	1,148	49.2	1.309	3,519	3,147
April 11, 1891.....	935	78.4	1.066	2,845	2,781
Inc. or dec. 1891.	— 213	+ 29.2	— 243	— 674	— 366
" per cent.	— 18.55	+ 59.34	— 18.56	— 19.09	— 11.63

In addition to the above we have also collected figures showing the progress of work in Ontario and the Eastern Provinces of Canada, and in the three Southern States shown wholly or in part upon our map. These are given in the following table:

	Track laid. 1890.	Track laid. To date in 1891.	Under contract or construction.	Located and under survey.	Projects of some promise.
Canada..	71.3	9	200	838	1,052
Va..... ..	236.23	60	148	522	263
W. Va...	95.5	32	282	131	171
Ky.....	185.3	..	33	490	525
	578.33	101	663	1,981	1,991

While, as before stated, these figures exhibit a considerable decrease from those published a year ago, yet, on the whole, they show a very favorable activity in railway construction in this section of our country. It is to be remembered that they are published shortly after one of the most severe financial stringencies of the last decade, and are compared with figures at the opening of a year of more than usual industrial activity, and during which more miles of new railway were built than at any time since 1887. In order to make a just comparison of the activity at the two dates, it is necessary to study the lines in detail.

We find that very little active construction is in progress in the New England States. In lines projected and under survey the State of Maine takes the lead with over 360 miles to its credit, and is followed next by Vermont with 60 miles.

The most important line shown on our map is the extension of the Lehigh Valley R. R. to Buffalo, comprising 150 miles of double-track railway. Work is now actively in progress on its entire length, and it is probable that a large amount of track will be laid this season. The object of the road is to give the company an outlet for its coal at Buffalo. Its completion, together with the construction of the proposed line into Philadelphia, which is probably not many years in the future, and the completion of the New York City terminals, will make the Lehigh Valley one of the most important systems in this section.

Another double tracked line of considerable length now practically graded is the 50-mile cut-off of the Pennsylvania R. R., from Downington, Pa., to Morrisville, N. J. This line is being built to accommodate the through freight traffic, thus avoiding switching delays at Philadelphia. It will be seen from this that the states of New York and Pennsylvania not only have a large mileage of new railway enterprises under way, but that this mileage includes some of the most important railway enterprises in the Eastern States. Among the other important lines under way in these states may be mentioned the surveyed extension of the Elmira, Cortland & Northern from Camden to Watertown, N. Y., 60 miles; the Herkimer, Newport & Poland, surveyed from Poland, N. Y., north into the Adirondack Lake region; the Saratoga, Johnstown & Western, surveyed from Saratoga to Utica, N. Y., 75 miles, and the Rome & Carthage, surveyed from Rome to Carthage, N. Y., 56 miles. In Pennsylvania the Titusville, Cambridge & Lake Erie R. R. has a line partly graded from Titusville to Erie, Pa., 50 miles, and the grading is well advanced on the extension of the Pittsburg, Shenango & Lake Erie, from Dixonburg to Girard, 26 miles. The Pennsylvania, Poughkepsie & Boston has a line located between Slatington and Harrisburg, 101 miles, but will probably do nothing toward construction this year. Among the other surveyed lines are the Cumberland Valley R. R., Fort Loudon to Mt. Dallas, 46 miles; the Western New York & Pennsylvania R. R., Newcastle to Oil City, 43 miles; the Pennsylvania, Lehigh & Eastern R. R., Port Jervis, N. Y., to Tomhicken, Pa., 100 miles, and the New York, Philadelphia & Chicago R. R., Franklin to Clearfield, 90 miles. This last enterprise is generally considered to be in the interest of the Beech Creek R. R., now leased to the New York Central & Hudson River R. R. All interest in the enterprise, however, is denied by the officials of the Beech Creek Co.

In the states of New Jersey and Maryland construction is not very active. The most noticeable of the lines included within their limits is the old, partly graded Baltimore & Drum Point R. R., and the prospects are not flattering for the early completion of this.

The most important work under way in Ohio is the line being built by the Baltimore & Ohio R. R from Chicago Junction to Akron. That this line will have a considerable effect upon the company's position in the through business from Chicago to the coast seems probable. The Baltimore & Ohio already has one of the easiest lines across the Alleghenies to Pittsburg. From Pittsburg to Akron the Pittsburg & Western R. R. will, when the various contemplated improvements are made, give the B. & O. an easy line for freight transport. The new line will connect from Akron with the Chicago line of the B. & O., and thus a new through line from Chicago to the coast will be formed, with a considerable saving in the matter of grades. Just how cheaply the new line can handle freight cannot now be said; but it seems probable that it can be done at a less cost per ton mile then by the present line through West Virginia.

Of the other lines in Ohio, the Columbus, Lima & Milwaukee R.R. is now grading between Lima and Defiance; the Lancaster & Hamden R. R. is rapidly grading several lines in the central and southern portions of the state, and there are several other short lines upon which work is now in progress. The Cleveland & Marietta R. R. has a line surveyed from Kimbalton to Loudonville, 68 miles, and the Sandusky, Columbus, Lake Erie & Southern R. R. has a line located from Sandusky to Columbus, 108 miles. Construction in Indiana is confined to the portion of the Findlay, Fort Wayne & Western lying within that state and to a short line into the coal fields near Brazil. In the northern part of the state the Wabash R. R. has a line projected from Butler to Chicago, and the Lake Shore & Michigan Southern Ry. has surveyed another from Charleston to Fayette, O., 150 miles.

In Michigan the work is confined to the western and northern portion of the state. The Manistee & Northeastern will probably complete its line to Traverse City this season, and the Manistee & Grand Rapids is building south from Manistee. The Chicago & West Michigan has a line located from Traverse City to Charlevoix, and will probably build in the near future.

The most important line under way in West Virginia is the extension of the Norfolk & Western R. R. from Elkhorn to Ironton, O., 195 miles. Grading is well advanced on this road, and tracklaying is now in progress. The West Virginia & Pittsburg R. R. is grading extensions into the mineral lands, and the West Virginia Central & Pittsburg has resumed work on its extension from Elkins south. Tracklaying is also in progress on the branch of the Ohio River R. R. from Ravenswood to Spencer.

The largest portion of the work in Virginia lies outside the limits of this map, and will be described in our map of the Southern States, to be issued shortly. In Kentucky there is very little active construction and the various lines are sufficiently described in our detailed list. The same is true of the portion of Canada shown on our map. The prospects for construction in the Dominion are not better than they were one year ago.

Considering the work as a whole, it is probably fully as active as the condition of affairs will warrant. The majority of the lines being built will prove a benefit to the region through which they run. The only paralleling schemes of any importance are in Northern Indiana, and these have not advanced beyond a preliminary survey. In general it may be said that a large proportion of the lines shown on our map will develop new industries and resources, and will help toward the general prosperity of the country.

CORRESPONDENCE.

Suggestions for a New Type of Subaqueous Tunnel.

NEW YORK, March 31, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The writer approaches with great diffidence the subject of this letter, the suggestions being of such a nature as may probably earn for him the reputation of a crank. He proposes, so far as he is aware, an entirely new departure in a branch of engineering of universal interest, viz., the connecting by railways of places divided by expanses of water more or less impassable by ordinary methods of bridging and tunneling.

The system herein proposed is based primarily on the assumption that, for all practical purposes, at a certain depth below the normal surface of the sea, say 40 ft., all the disturbing forces of the waves in the greatest storm cease to act to any appreciable extent, and the water from that point down is, to all intents and purposes, motionless at all times; for the possible existence of deeper currents in such a place as the British Channel, for instance, if appreciable at all, would be so slight as to be easily provided against and vastly less complicated in their dynamic effect than the strains that have to be calculated on for a suspension bridge subject to enormous wind pressures in hurricanes or gales traveling at the rate of 80 miles an hour. A steady water current of even 5 miles per hour, which is hardly possible, would have very little injurious effect on a long tube, necessarily possessing a considerable degree of elasticity. Suppose, therefore, that a watertight tube could be held in suspension at that depth by suitable means; a tunnel of the simplest and cheapest construction, without the expense of boring, could be made where at present, from various causes, it would be both costly and inconvenient to construct either a bridge or tunnel in the ordinary way. It is not proposed in this paper to do much more than broach the subject in a general way, and the sketches given are little more than diagrams to illustrate the idea, which, if considered worthy of discussion at all, may be developed in detail hereafter. But the writer believes he has made calculations enough to prove that a tunnel so constructed would be in every way better and safer and cheaper than any bridge or tunnel yet proposed for such places as the English or Irish channel.

The sketches given show a double tube of iron for a double-track road, divided along the center both for stiffness and safety, as in this way the most fearful accident to one side of the tube would not sink it by the admission of the water. The tubes are bolted together in any desirable lengths, and instead of resting on supports their displacement and consequent buoyancy cause them to be *suspended upward* from the supports, if such a term may be used. The supports here shown are iron screw piles of suitable dimensions, the tube being at a depth of, say, 40 ft below the surface of the sea. The ventilating shafts shown may also be placed wherever desirable and suitably secured with stays, as the horizontal force of the waves in mid-sea is not great. But these shafts are merely a suggestion that may or may not be found practicable; they do not in any way constitute an essential feature of the tunnel, and the tunnel itself may have any desirable grade from the center to the shores for efficient drainage.

Before proceeding to show the capability of such a structure to sustain any pressures or weights that may be needed, I will say a word with reference to the first natural objection that will suggest itself, and, as far as I can, now see, the only one that can be advanced to such a tunnel, *i. e.*, the supposed rapid deterioration of iron or steel under such conditions by the corosion of seawater; but while admitting this difficulty to exist in some cases, I do not think it is a fatal one. Iron may be protected in various ways more or less costly and practical, but supposing the other advantages of such a structure to be admitted, the question narrows itself down to one of experiment as to the best means of effectually protecting iron when exposed to the action of seawater, by any process of coating, with any substance that would be more or less effective in that way; and, further, the writer doubts if under the conditions described the iron would be seriously affected at all, because it is well known that iron ships in a few months get so covered with aquatic growth below the water line as to seriously affect their speed and necessitate periodical removal of such growth. It is therefore not unreasonable to suppose that the tubes in question, at a depth of 40 ft. below the surface, would be subject to the same conditions of growth, and in course of time, with the accretion of sediment, encase themselves in a perfect covering of considerable thickness, enough for their own protection.

We will now pass to the consideration of the stability of such a structure under the weights and strains it would be called upon to sustain. Suppose we take a section of 50 ft. of the form shown in Figs. 1 and 2, made of a white cast-iron outer skin 2 ins. thick, with all the necessary interior trussing of wrought iron, longitudinal and otherwise, with track laid, and lined on the inside of its trussing throughout with sheet iron, forming a double skin. Its weight all complete would not exceed 60 tons which, with a cubic capacity of 35,850 cu. ft., would give a buoyancy in seawater of 968 tons, certainly more than sufficient to insure steadiness under the heaviest train of locomotives ever yet built. This excessive buoyancy is merely stated to show beyond question the strength and stability of the structure under any possible load, but in practical construction it would be found expedient to considerably increase the weight of the tube with a heavy lining of concrete and ballast on the track throughout so as to decrease the strain on the chains and the anchorages, which can be thus regulated to any degree.

Now, provided that the tubes are so constructed as to resist bending upward between the supports, and provided the supports themselves are of sufficient dimensions to resist such an upward strain, we have practically a reversed suspension bridge truss, supported at all points from without, and as safe as though lying on the ground; safe from strain of wind and weather, or other element of uncertainty. The side chains would provide against possible deep-sea currents, being anchored to a separate row of screw piles on either side of the main central line, which would represent, in a measure, the wind stays of suspension bridges. There is very little question that the joints of lengths or sections can be made water-tight under a head of only 40 ft., and the tunnel would be no obstruction whatever to the navigation of the heaviest iron-clad afloat.

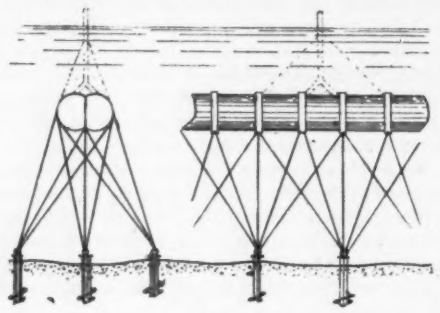


Fig. 1.

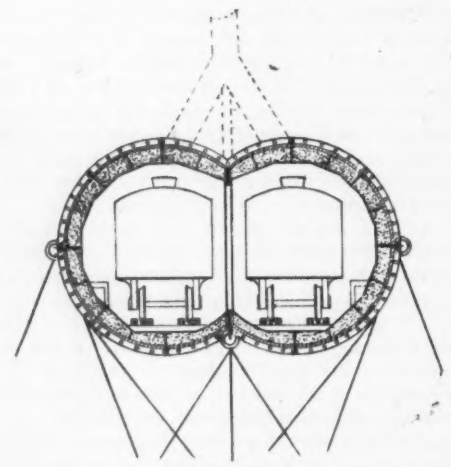


Fig. 2.

A brief outline may here be given of the method proposed for screwing down the piles, the question of their number being immaterial and governed only by economical considerations. Spaced 50 ft. apart in three rows we would need approximately 6,900 piles for the 22 miles across the British Channel, their size and length being regulated merely by the strain they would be required to withstand, and the nature of the soil into which they would be driven. As I will show, neither the depth of the water nor the size of pile need be considered a serious difficulty, within reasonable limits. Suppose a hollow cast-iron screw-pile, 3 ft. in diameter, to be screwed 20 ft into the bed of the channel, in 150 ft. of water, and to project 5 ft. above the ground, this pile would be 25 ft. long, and made strong enough to withstand torsion, and furnished with its proportionate screw flanges. Suppose a large square iron punt, capable of carrying 8 or 10 lengths of such tubing, suitably jointed, with the necessary derricks and machinery for hoisting and lowering them through a large hole in the center. The punt would be anchored at the four corners over the site of the pile, which would be lowered and jointed together at the top until the bottom was touched, when the capstan head would be fixed, consisting of two girders, say 50 or 100 ft. long, hinged vertically, and attached at their outer ends to two steam tugs provided with detachable, curved or one-sided cutwaters enabling them to turn in any circle. We have here power unlimited for screwing down any size of pile to any depth (the water-jet being used down the center of the pile to the flanges), and when screwed to the required depth the upper lengths would be detached and hoisted successively for use on the next pile. In short, as we need to bore a very large hole, we use a very large gimlet of the simplest construction. The sections of the tunnel itself, in any desirable lengths, being put together on shore and closed temporarily at both ends, so as to be floated into position, would then be sunk by the admission of water to any extent and bolted on in succession as fast as the supports could be screwed down. The temporary ends would then be removed from the interior and the water pumped out.

The question of the anchorage and attachments, though perfectly simple of execution, in the opinion of the writer, and possessing ample guarantees for reasonably perfect safety, can hardly be demonstrated to be so from lack of trustworthy data in that particular line; that is to say, screw piles are ordinarily intended to bear weights from above, while in this case they would be wanted to withstand a force tending to tear them out of the ground. In the first place, however, it must be borne in mind that this force would be reduced to what was barely necessary to support the weight of passing trains by making the tube itself as heavy as possible with a due margin of safety. What force must we then estimate to be necessary with a straight pull to draw out a screw pile, say, 3 ft. in diameter, with flanges projecting 18 ins. or more all round, and driven to a depth, say, of 20 ft. into the ground? The writer confesses that he is unable to approximate it very closely; but he, nevertheless, believes that even with all its length in comparatively soft mud in the bottom of the sea it would have a resistance greater, almost, than could be brought against it by the power of man, and so much greater than the comparatively few tons that would be applied to it under the conditions considered as to remove entirely all fears on this head. The smooth piles, 1 ft. in diameter in the foundations of London Bridge bear each a weight of 80 tons. Their resistance in the opposite direction would not be much less, so a flange area as above, 36 times that of the smooth pile, would on this assumption alone resist a pull of about 3,000 tons; while the chains holding the tubes might be as many as 50 in number, if desirable, attached to 3 or more piles for each 50 ft length, and certainly capable of being proportioned to withstand it. Should any of these anchorages yield slightly at any time or break, the section affected could be closed temporarily and filled with water, thus relieving the strain and permitting repairs.

The principal advantages claimed for this proposed system are:

1. Simplicity and rapidity of construction.

2. Natural lighting and ventilation, if desired, by shafts to the surface at any desirable distance apart, serving also as a means of communication with the surface for repairs, or in case of accident, and lighting or marking the position of the tunnel; these shafts as before stated being optional, not essential.

3. Economy in pumping any leakage from a depth of 50 ft. as against the enormous depths necessary in an underground submarine tunnel of ordinary type.

4. The easy grades necessary to reach so slight a depression, no extended tunnelling on land or heavy terminal expenses for property being incurred.

5. Economy in cost of supports as compared with the costly foundations for a bridge in a similar position, while the tunnel causes no obstruction whatever to navigation.

6. Economy in first cost of the entire structure, the actual amount of iron-work being vastly less than for a bridge.

7. The comfort of travel, this being vastly superior to that through ordinary tunnels and the safety greater than that of a bridge subjected often to varying strains from gusts of wind of enormous force. Even supposing any accident either from the inside or the outside of the tunnel, so long as both the skins of both the tubes were not pierced, the tunnel could not sink.

8. In conclusion it may be remarked that this form of tunnel completely overcomes the strategic objection brought against an underground tunnel between England and France, as the fleets of either nation would have perfect control over it, it being easy to flood a section or destroy any part or the whole of it with torpedoes from above, while its terminal points would be within easy range of guns from the sea. Of course, if the tunnel were being built as a means of offence or defence this would be a decided disadvantage, but it is not, and would not be destroyed except under the most pressing necessity, in which case it would be no worse off than a bridge.

Such, then, are the suggestions which, if admissible in their present form, may at least contain the germ of thought for further development, and it is with this hope only that the writer presumes to make public a proposal which even to himself seems visionary in view of its wonderful possibilities of adaptation in other situations than that named above, as, for example, to life saving or signal stations at sea, lighthouses under water with electric light machinery and a simple tubular stairway communicating with a gallery above the surface, and the light projecting on a light pole to any height, the lighthouse being

placed in comparatively deep water, instead of being actually on the dangerous shoals or rocks. Many other uses will suggest themselves, almost too good to be true, even in the progressive engineering of the nineteenth century. If, then, we can overcome a natural amount of prejudice against innovations generally, and this form of construction can be proved at least reasonable, can any one suggest a reason why it should be any more dangerous than the suspension bridges which we cross every day?

J. T. FORD, Assoc. M. Inst. C. E.

The Stand-Pipe Failure at Temple, Tex.

TEMPLE, Tex., Nov. 1, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The new steel stand-pipe at Temple, Tex., burst and fell about 2:30 A. M. on Oct. 25, 1890. The stand-pipe had not been received from the contractor, but had been filled by the water company several days previous to the accident for the purpose of testing the work. The outside scaffolding had not been removed, as the contractor was engaged in calking up a number of leaks near the bottom of the stand pipe, and had another coat of paint to add before the completion of the work.

The following description is taken from the plans and specifications, checked by notes on the ground after the wreck. The stand-pipe was 20 × 120 ft. high. The bedplate was 7/16-in. thick and beginning at the bottom, the side plates were as follows, there being 24 rings, each 5 ft. high:

Section.	Number of rings.	Thickness of plate, ins.
1	2	5/16
2	2	9/32
3	2	7/32
4	3	5/16
5	3	9/32
6	4	5/16
7	4	1/4
8	4	3/16

All vertical seams were double riveted, the horizontal seams on the first and second sections being also double, and all other horizontal seams single riveted. The angle iron connecting the sides to bedplate was 6 × 6 × ¾ in. double riveted to both plates with 1-in rivets spaced 2¼ ins. between centers. Also an inside ring of 2½ × 2½ × 5-16-in. angle iron 65 ft. from the bottom, and an inside rim at the top of 3 × 3 × 5-16 in. angle iron were riveted to the side plates.

Twelve 1¼-in turnbuckle anchor bolts extended from cast lugs on the tower to bottom of foundation. A manhole 20 × 20 ins. and a 6-in. flange water connection, both cast-iron, were riveted on at bottom of stand-pipe. The specifications call for a foundation of concrete composed of "three parts broken stone, two parts of sharp sand and one part of fresh cement." The top diameter of foundation was 22 ft., the bottom diameter 34 ft., and the depth 6 ft. The concrete rests on a soft white clayey limestone.

The quantity of plate metal called for is "steel, 60,000 lbs. tensile strength, free from flaws or blisters."

The failure was attended by an explosive sound, followed by the noise of the rush of water and the fall of the stand-pipe and neighboring structures. The tower being located at the highest point in the residence portion of the city, and being full of water at the time of failure, the damage to property was severe. Besides the general destruction of outbuildings, one residence was lifted bodily and badly damaged by the water, another being crushed and subsequently destroyed by fire. A man occupying the latter building died from burns received from an overturned lamp.

The lower third of the tower was totally demolished, and the plates were thrown in a torn mass 50 to 60 ft. eastward, a few fragments being carried in other directions. The remaining portion, 80 ft. in length, fell to the westward, collapsing as it struck.

As yet no definite cause for the failure has been proved. The theory that the stand-pipe was destroyed by dynamite, based mainly on a long gash near the southeast edge of the bedplate, is without foundation, as this and another similar fracture of the bedplate were made by the edges and corners of falling plates which may be readily found. The most plausible explanations are based upon the failure of plates in which the unequal settlement of the foundation may have had some influence.

The character of the wrecked plates cannot be better described than by quoting from the description of the Gravesend water tower failure given in ENGINEERING NEWS, Vol. XVI., p. 264:

> An inspection of the wreck shows a most wonderful rending and distortion of metal. The entire bottom or wider part of the tower is torn to pieces and large fragments of the plates were projected to a distance of 50 to 60 ft. from the foundation. The plates themselves form a curious exhibit; some are bent almost double and others are actually rolled up, showing a very tough metal. On the other hand, a number of the plates are broken in a manner showing a brittle, almost glassy structure, and others again present a much serrated edge, with long, dagger-like projecting points.

So far as I know no inspection was placed upon the material or workmanship.

Ripley & Bronson, of St. Louis, Mo., were contractors for the entire structure. Thomas & Gorman, of Houston, Tex., who have erected a number of stand-pipes in the state, were sub-contractors for erecting the Temple tower, the foundation having been put in by local parties.

W. D. PEIRCE.

[A note concerning this stand-pipe failure appeared in our issue of Nov. 1. The Gravesend stand-pipe was 250 ft. high. It was 16 ft. in diameter for 50 ft. from the bottom, then decreased to 8 ft. in the next 25 ft. in height, and continued of the latter diameter to the top.—ED. ENG. NEWS.]

Radial Truss Bridges.

BALTIMORE, Md., March 24, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Talking about Mr. PEGRAM'S carefully designed radial truss bridges with curved top chords, recently illustrated and discussed in your valuable paper, did you ever see the "great and only original" radial truss as drawn and set forth in the enclosed copy of my *expired* patent No. 128,449 of June 25, 1872?

The language used in Claim No. 1, and in those portions of the specification within the red lines, seems to state clearly the arguments for the radial truss of to-day, although these arguments were written nearly 20 years ago, in the days of short panels, straight top chords and double intersections, and I would suggest that you republish them, together with Fig. 1 of the patent, for the benefit of all concerned if you can find the space in your very useful columns.

I was unable to make the radial principle "go" in those early days even with the full-hinged joints, which were then coming into use (please consider this as my apology for the old-fashioned joint boxes shown in my patent), because there was not enough duplication of parts to suit the shop men, and when I talked about applying the curved top chord to the radial, as used in the Whipple and Pratt trusses, the pound prices ran up faster than the pound weights ran down, and I am glad that my friend PEGRAM has been able to make it "hump" itself.

FREDK. H. SMITH.

[Extract from specification of Letters Patent No. 128,449, dated June 25, 1872, to Fred. H. Smith, of Baltimore, Md.]

On all systems of truss-frames for bridges in which both top and bottom chords are used connected vertically and laterally by bracing systems composed of struts and ties, it is known, first, that the horizontal strains of compression and tension in the chords are greatest in the middle of the span and diminish in intensity toward the ends; second, that the vertical and diagonal strains of compression and tension in the vertical bracing system are greatest at the ends of the span, and diminish in intensity toward the middle; third, that the strength per square inch of sectional area of compression members increases in a certain proportion to the increase of diameter as compared to the length between supports; fourth, that compression members in vertical bracing systems should have as much inclination within the theoretically economical angle of 45° as is compatible with a sufficient ratio of diameter to length to insure them against flexure or dangerous vibration; fifth, in all bridges of ordinary lengths of span it is necessary to waste material in those compression members which carry the minimum strains, because the members must in any event be of a certain proportionate diameter to resist flexure and vibration, whereas the minimum strains are generally so small at these points that they do not utilize a tithe of the sectional area of members made large enough to resist flexure and vibration.

In the bridge I propose the compression members *A* of the vertical system are vertical at the center of the span, and inclined at the ends, as shown in Fig. 1, the intermediate posts varying in inclination more or less as they are nearer to the ends or the center, the center lines of the posts being radial and converging to a common central point above the span center, by which design I gain the following advantages: First, in all other bridges within my knowledge the panels of the top chord are equal in length to those of the bottom chord; but in my design, while retaining the same economical length of panel for bottom chord as in other plans, I reduce the length of panel in the top chord, thereby materially increasing the ratio of diameter to length, and consequent capacity per square inch of sectional area, and also lessen the amount of waste material in end panels subject to minimum strains. Second, in the vertical bracing system the strains are smallest in the middle of the span; and at this point my posts are vertical and shortest, thus again keeping down to a minimum all waste on account of light strains, while by successively increasing length, inclination and sectional area of the posts toward the ends of the span as the strains increase I am enabled to utilize the material to the best advantage. My bridge is thus a medium between those forms of truss in which the posts all incline at the same angle and those in which the posts are all vertical—the first form being economical at the ends and wasteful at the middle, the second form being economical in the middle and wasteful at the ends while my design is eclectic and utilizes the economical features of both the ordinary plans, and forms a distinct system in itself.

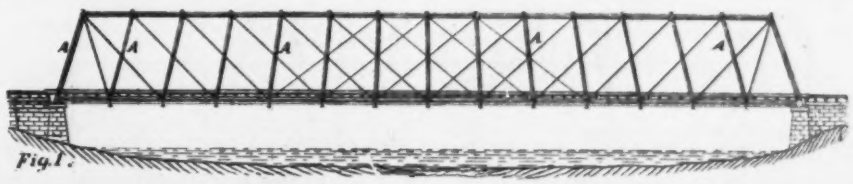


Fig. 1.

RADIAL TRUSS BRIDGE, DESIGNED BY F. H. SMITH. (From Expired Patent, No. 128,449, June 25, 1872.)

I do not confine myself to any particular inclination for the posts, as this will necessarily vary with conditions of span or depth of truss, or the number of intersections of systems, or the materials of members.

Claim 1. A bridge-truss in which the posts or compression members of the vertical system are radial from a central point above the span center, as shown and described.

Transit Notes of Preliminary Surveys.

MANKATO, Minn., March 23, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR—Several ideas regarding the proper mode of keeping transit notes on preliminary surveys have been given of late in ENGINEERING NEWS, of which I am a constant reader, and which I look for every week as I look for a good friend. I consider the best method is to work from bottom to top of page, thus keeping the line always before you, and, when you come to draughting, it is much easier to work from notes kept in this way. I send you a page from a transit book with notes taken last October by one of my transitmen on railroad surveys. It will explain itself, and I think it a very plain easy method.

F. D. WOODBURY.

Sta.	Angles. Left.	Angles. Rig't	Mag. C.	Figured bearings. Comp'd C.	Variation 0° 30' E. (Center of Book.)
2821 + 16		0° 30'	N. 11° 45' E.	N. 11° 45' E.	
2816 + 30		1° 00'	N. 11° 45' E.	N. 11° 15'	
2810 + 92	2° 00'		N. 10° 15' E.	N. 10° 15' E.	
2780 + 98		27° 00'	N. 12° 15' E.	N. 12° 15' E.	
Monday, Oct. 8, 1890. Rough, windy weather in A. M., rain'g in P. M., and walked 6 m. to camp.					
2735 + 24		14° 00'	N. 14° 45' W.	N. 14° 45' W.	
2763 + 05		3° 00	N. 28° 45' W.	N. 28° 45' W.	
2745 + 77		2° 00'	N. 31° 45' W.	N. 31° 45' W.	
2744 + 96	24° 30'		N. 33° 45' W.	N. 33° 45' W.	
2741 + 73		11° 30'	N. 9° 15' W.	N. 9° 15' W.	
2740 + 50		1° 00'	N. 20° 45' W.	N. 20° 45' W.	
2730 + 52	2° 30		N. 21° 45' W.	N. 21° 45' W.	
2729 + 22		58° 00'	N. 19° 15' W.	N. 19° 15' W.	
2721 + 27		25° 30'	N. 77° 15' W.	N. 77° 15' W.	

[This is a very good form, with two important exceptions, or rather additions, which are:

1. The column marked "Computed Course" should actually be courses read from the vernier, as follows: In starting work at 2721 + 27 a sight is taken on the foresight at 2729 + 22, the needle dropped and found to read N. 77° 15' W., as shown, and the vernier set to read 77° 15' also, on the proper side of the zero point, so as to bring the zero line of the vernier on the true magnetic north, or directly under the needle. Thereafter the vernier is never reset; it is simply examined after moving ahead, to see that it has not slipped. When an angle is to be laid off, the plates are unclamped above and the telescope given the desired direction, but the zero line of the vernier remains continuously north and south when the instrument is set, and the vernier reading and needle reading remain continuously the same. In passing from the N. to the S. quadrants, the form of the readings is not quite the same, but even this trifling source of confusion may be avoided by reading both needle and vernier in the same way, either 180° each way from N. to S., or 90° each way from both N. and S.

In this way the chance of angular error is almost wholly eliminated. The actual angles turned off are not directly read, but must be determined by subtraction; but the actual angles are not needed, and in good practice are never used, for plotting. We may add that one will rarely or never see as close agreement beetwen magnetic and computed bearing as the table shows, if the bearings are honestly and independently read.

2. The right-hand page of a notebook kept in the form shown should be devoted to the latitude and departure calculations, these being read off for each course from a diagram in a way we have often explained. These latitude and departure calculations, however, are desirable only when a very long line of

survey is to be plotted to a small scale. Otherwise, when only a few courses come on any one square yard or less of paper, the better mode of plotting, and the only one used by the well posted, is to lay off all the desired courses at once from a single center on a north and south line (or line of other known course), and transfer them in succession by a *large and well-made* parallel ruler (not the cheap affairs which are most common) to the desired points.—ED. ENG. NEWS.]

Breaking Cement Briquettes at the Smallest Section.

BALTIMORE, Md., April 3, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I have been testing cements for some months for the Baltimore Belt R. R., using a Riehle machine. The form of the clips is slightly different from that recommended by the Committee of the Am. Soc. C. E., the difference being that the clips have a bearing surface on the briquettes of ⅝ in. I have been greatly annoyed by the fact that about 50% or 60% of the briquettes broke where the clips grasped them, and have tried various ways of remedying the evil—by the use of small pieces of cardboard, blotting paper, etc., between the briquettes and the clips, as recommended by correspondents in ENGINEERING NEWS of Oct. 4 and Dec. 20, but the results have been far from satisfactory. Acting on a suggestion made to me to use thin pieces of rubber in place of the card board, I am now using a thin rubber band about 3¼ ins. long and ¾ in. wide, which is placed longitudinally around the briquette. For convenience in adjusting the clips, a short and narrow band is used to hold the large band close to the small section of the briquette. The results gained by this method are most satisfactory, from 90 to 95% of the briquettes breaking at the smallest section. It is but the work of a moment to adjust the bands to the briquette and the briquette to the machine.

JANON FISHER.

Tests of Paving Brick.

We are indebted to Mr. E. BUTTS, City Engineer, of Kansas City, for the accompanying record of tests made by him on March 20 to determine the crushing strength, porosity and resistance to abrasion of specimens of paving brick from different makers. To show more clearly the great variation of the specimens, and the relation of these qualities to each other, we have plotted the results in the accompanying diagram. Of course the variation in different bricks from the same manufacturer is likely to be considerable, even when all care is taken to select specimens of uniform character for tests. Neglecting extreme variations, however, the diagram shows pretty definite relations between the qualities tested, the strongest bricks (presumably burned the hardest) absorbed very little water, but were brittle enough to lose about as much by abrasion as bricks somewhat weaker. The abrasion line, however, is remarkably uniform, with the exception of one very porous sidewalk brick. This is perhaps due to the fact that the stronger bricks were brittle enough to lose by chipping the corners, while the weaker but tougher bricks lost by actual wear on the sides.

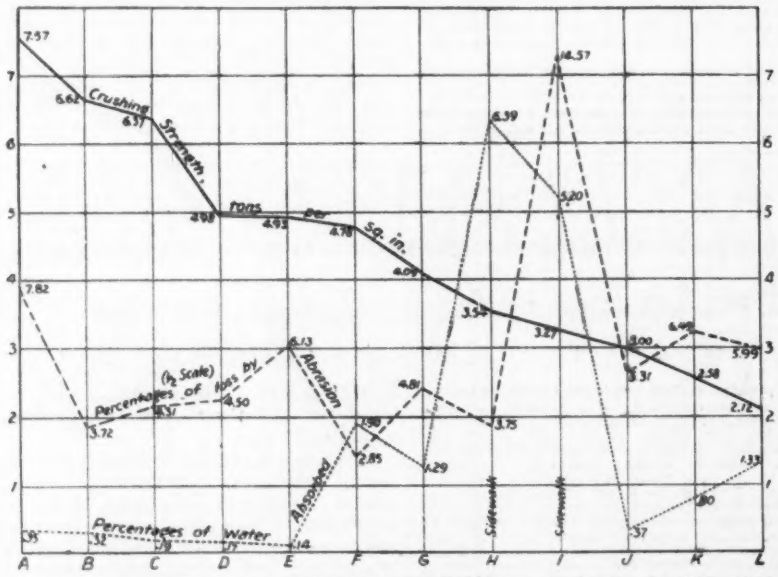
The crushing test was made in a hydraulic press on half bricks laid flat. The absorption test was made by breaking a brick in two as near the center as possible, thus exposing its interior, and immersing it in water for 48 hours. Mr. BUTTS remarks that many of the bricks showed laminations or lack of vitrefaction in the interior. The abrasion test was made by placing the brick in a foundry rattler with about 600 lbs. of small castings, weighing from ¼ lb. to 3 lbs., and running the rattler at about 100 revolutions per minute for 15 minutes. The last test seems the one of greatest importance, and it has the advantage that it is very easily made.

TESTS OF PAVING BRICK AT KANSAS CITY, MO.

Pressure tests.	Size.			Top surface area.	Crushing strength.	Strength per sq. in.	Relative standing
	Length.	Width.	Thick.	Sq. in.	Tons.	Tons.	
(A) King Hill Brick Co., St. Joseph	4.87	3.87	2.25	18.89	143	7.57	1
(B) Sam Currier, Deepwater	3.62	3.75	2.12	13.59	90	6.62	2
(C) Diamond B. & T. Co., Kansas City	3.37	3.62	2.12	12.23	78	6.37	3
(D) Beattie & Benning, Atchison	3.37	3.75	2.25	12.65	63	4.98	4
(E) S. A. Robinson, Des Moines	3 62	3.75	2.25	13.59	67	4.93	5
(F) Mo. Clay Co., Deepwater	3.75	3.62	2.37	13.59	65	4.78	6
(G) Boyd & Son, Knob Noster	3 62	3.37	2.25	12.23	50	4.09	7
(H) Hydraulic P. B. Co., K. C. (sidewalk)	3.87	4.00	2.31	15.50	55	3.54	8
(I) Diamond B. & T. Co. (sidewalk)	3.62	3.62	2.37	13.14	43	3.27	9
(J) Brick & Terra Cotta Co., St. Joseph	3 75	4.00	2.50	15.00	45	3.00	10
(K) Osage City Brick Co	3.62	3.75	2.06	13. 9	35	2.58	11
(L) Brick & Tile Co., Deepwater	3.25	3.62	2.25	11.78	25	2.12	12

Absorption test.	Size.			Surface area.	Orig. wt.	Wet wt.	Diff. of wt.	Per cent. of gain.	Relative standing
				Sq. in	Lbs. Oz.	Lbs Oz.	Oz.		
(E) S. A. Robinson, Des Moines	3.5	3.3	2.3	54.38	2 11.45	2 11.51	0.06	0.14	1
(D) Beattie & Benning, Atchison	4.5	3.6	2.3	69.66	2 14.30	2 14.38	0.08	0.17	2
(C) Diamond B. & T. Co., Kansas City	4.2	3.5	2.1	63.71	2 10.89	2 10.97	0.08	0.19	3
(B) Sam Currier, Deepwater	3.7	3.7	2.3	61.42	2 8.93	2 9.06	0.05	0.32	4
(A) King Hill Brick Co., St. Joseph	4 3	3.9	2.3	71.26	3 3.25	3 3.43	0.18	0.35	5
(J) Brick & Terra Cotta Co., St. Joseph	4.2	4.0	2.5	75.25	3 5.87	3 6.07	0.20	0.37	6
(K) Osage City Brick Co	4.1	3.6	2.1	63.84	2 14.19	2 14.55	0.37	0.80	7
(G) Boyd & Son, Knob Noster, Mo	3.7	3.7	2.3	63.38	2 9.10	2 9.63	0.53	1.29	8
(L) Brick & Tile Co., Deepwater	3.5	3.2	2.2	52.45	2 3 96	2 4.44	0.48	1.33	9
(F) Mo. Clay Co., Deepwater	3.9	3.9	2 3	66.30	2 9.61	2 10.43	0.79	1.90	10
(I) Diamond B. & T. Co. (sidewalk), K. C.	2.8	3.8	2.3	52.25	1 14.39	1 15 97	1.58	5.20	11
(H) Hydraulic P. B. Co., K. C (sidewalk)	4.0	4.0	2.3	69.60	2 13.80	3 0.72	2.92	6.37	12

Wearing test.	Size.			Surface area.	Orig. wt.	Worn wt.	Diff. of wt.	Per cent. of loss	Relative standing
				Sq. in	Lbs. Oz.	Lbs. Oz.	Oz.		
(F) Mo. Clay Co., Deepwater	8.1	3 8	2.2	113.96	5 5.37	5 2.12	3.25	2.85	1
(B) Sam Currier, Deepwater	7.7	3.6	2.2	107.28	5 6.25	5 2.25	4.00	3.72	2
(H) Hydraulic P. B. Co., K. C. (sidewalk)	8.2	4 0	2.2	120.50	5 7.75	5 3.25	4.50	3.75	3
(C) D. Brick & Terra Cotta Co., K. C.	8.2	3.4	2.2	107.36	5 2 19	4 13.56	4.63	4.31	4
(D) Beattie & Benning, Atchison	7.8	3.5	2.2	105.45	5 4.37	4 15.62	4.75	4.50	5
(G) Boyd & Son, Knob Noster, Mo	8.0	3.7	2.3	113.02	5 10.25	5 4.81	5.44	4.81	6
(J) Brick & Terra Cotta Co., St. Joseph	7.8	4.1	2.4	122.25	6 8.50	6 2.00	6.50	5.31	7
(L) Brick & Tile Co., Deepwater	7.8	3.7	2.2	109.47	5 1.12	4 10.56	6.56	5.99	8
(E) S. A. Robinson, Des Moines	7.9	3.75	2.4	115.17	6 1.37	5 10.31	7.06	6.13	9
(K) Osage City Brick Co	7.6	3.7	2.2	105.96	5 1.00	4 10.12	6.88	6 49	10
(A) King Hill Brick Co., St. Joseph	8.0	3.8	2.3	115.08	5 15.00	5 6.00	9.00	7.82	11
(I) Diamond B & T. Co. (sidewalk), K. C.	7.8	4.0	2 3	116.68	5 10.37	4 9.37	17.00	14.57	12



TEST OF STRENGTH, POROSITY AND RESISTANCE TO ABRASION OF PAVING BRICKS FROM DIFFERENT MAKERS. (Letters Refer to Names of Makers in Table.)

Electric Percussion Drills.

In our issue of Oct. 4, 1890, we published a paper by Mr. CHAS. J. VAN DEPOELE, the well-known electrician, describing the general principles of the mechanism by which an electric current is made to actuate a reciprocating engine. The principal application which has been made of this invention is in the construction of a percussion rock drill, to be operated by electricity. Several firms have been hard at work on this problem for some months. The Thomson-Houston Co., with which Mr. VAN DEPOELE is associated, will probably have a rock drill on the market in a short time and probably other applications of the reciprocating engine for light fast running power hammers, calking tools and similar uses may be expected.

The Edison company, however, is the first to bring the invention to the marketable stage; and our advertising columns have for some time shown perspective views of different forms of pecussion drills offered by the company. A report has been sent us of a test of the Edison electric drill in a granite quarry at Quincy, Mass., on March 27. The drill bored a 1⅛ in. hole in the hard Quincy granite at an average rate of 2¾ ins. per minute, with an expenditure of less than 4 HP. delivered to the generator. The speed of drilling at times was as high as 4 ins. per minute.

The generator was placed on the edge of the quarry, 350 ft. from the place where the drill was at work, and 100 ft. above it. To show the ease with which repairs could be made, the drill was taken entirely to pieces, which required less than three-quarters of an hour. All the parts of the drill are made of standard size, so that, by keeping on hand duplicates of all parts liable to breakage, the drill may be quickly repaired. The facility of repairs and the ease with which drills can be run at a considerable distance from the central power plant are, we understand, the chief claims of superiority made for the electric drill. The compressed-air drill on the other hand, has the great advantage in underground work that its exhaust provides ventilation, and cools the air. There is, however, a great amount of open-air drilling, in which the electric drill has a fair chance to compete.

The Prevention of Leakage Around the Tubes in Boilers Using Forced Draft.

How to build a boiler for marine service which will endure satisfactorily the strains due to forced draft was characterized by Lord RAVENSWOOD, the President of the Institution of Naval Architects, in his address at its recent meeting, as the chief engineering problem of the day. It is a problem which has received comparatively little attention in this country, except in locomotive practice; but the rapid growth of the ship building industry in this country, and the extensive use of forced draft, which is now almost universal in the navy, and is growing in favor on merchant vessels and in stationary work, makes it a problem of great importance here.

At the recent meeting of the Institution of Naval Architects, an important and very complete paper on the above topic was presented by Mr. A. F. YARROW, of the firm of Yarrow & Co., whose fame as torpedo-boat builders is world wide.

Many of the illustrations and experiments of Mr. YARROW were taken from locomotive construction, and his paper has such a direct bearing on this topic that it should be read by every one interested in locomotive work. Concerning forced draft for marine boilers the situation in the British Navy may be briefly summed up as follows: When first introduced it was hailed as the greatest improvement in marine engineering for many years, and it was applied to all new ships as fast as built. Disastrous experience has shown that on most boats every time the forced draft is used a good share of the tubes begin leaking as soon as the forced draft ceases. This, with other troubles, has led to the issuance of an order prohibiting the use of forced draft on the vessels fitted for it, except in cases of great emergency, where the safety of ship or crew may depend on the increase of speed which the forced draft alone can secure. The firm of Yarrow & Co., however, has won wide distinction by its successful use of the forced draft where others have failed, and Mr. YARROW's paper, which is a thoroughly practical one, has therefore been looked for with much interest.

His most important recommendations are the use of thin tube plates, ⅛ in. or even less; best material, methods and workmanship in tubes and plates; and arrangements for elastic movement of the various parts, to avoid the strains due to unequal expansion. We reprint the substance of the paper as follows. The illustrations accompanying the paper are reproduced from *Engineering* and *The Engineer*.

WORKMANSHIP AND MATERIAL.

A certain amount of trouble with leaky tubes is due to poor workmanship and material. With forced draft and high pressures boilers are severely strained, consequently workmanship which was good enough a few years ago is now quite unsuitable.

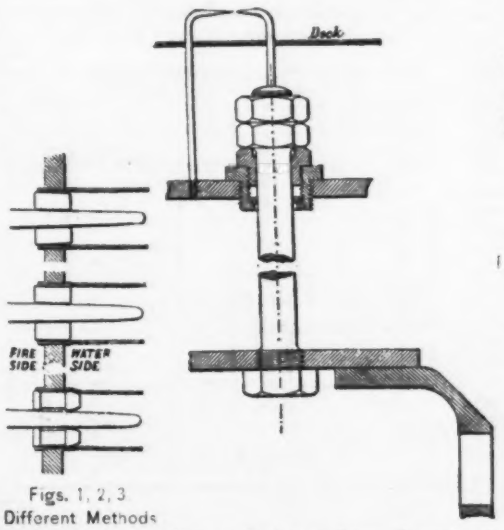
Tubes.—The best that are procurable are none too good. Good tubes are of the most ductile material and carefully annealed at the ends, and will stand flattening and bending over without cracking. They should be perfectly straight, or if curved, as is sometimes done, they should be all curved alike, so as to maintain the same water space throughout their entire length and secure a uniform elasticity. The thickness of the tube at the part where it is expanded must be the same all round; and there should be no ridges inside caused by the weld, otherwise the expander meets with inequalities, leading to irregularity in the work. The outside of the tube, where it passes through the tube plate, should be bright, so that the metal of the tube will be in close contact with the metal of the plate. Tubes polished at the ends are generally well greased to protect them from rust. This grease, as well as the oil remaining in the holes of the tube plate after having been drilled, must be completely removed; if this is not done, there will remain in places a film of grease between the two surfaces after the tube has been expanded.

Expanding Tubes.—The usual method is to bore parallel holes in the tube plate and expand the tube with a taper expander. Now, in no other part of the machinery should we think of putting a taper pin into a parallel hole. If the hole is parallel an expander should be used which will expand the tube so that it also becomes parallel; or if a taper expander be adopted, then the hole in the tube plate should be bored to correspond, so as to insure the perfect bearing of the tube throughout the entire thickness of the plate.

Fig. 1 shows the common method of expanding tubes. The defect in the fit is due not only to the fact that a taper plug is put into a parallel hole, but that the rollers do not go sufficiently far into the tube. They should go as far in as is shown in Fig. 2; and a still better method of expanding is shown in Fig. 3. The roller is parallel for a length a little more than the thickness of the tube, and is then of larger diameter. A well-defined shoulder is thus raised on both sides of the tube plate. This method of tube expanding is now in use at the Crewe shops of the London & Northwestern Ry. and at the Baldwin Locomotive Works, Philadelphia. Another mode of accomplishing the same thing is to reduce the diameter of the tube where it passes through to the tube plate.

In putting in tubes, as generally done, the boiler maker settles himself down comfortably inside the box and works away at one side or at one corner, expanding a large number of tubes and then shifting his position. This is objectionable, because by expanding a great many tubes in one place a considerable strain is thrown on the plate, which is stretched, and in this way severe local strains are set up. The better plan is to expand three or four tubes in one locality, and then shift to another, expanding all over as gradually and uniformly as possible.

Some people advocate screwing the tubes into the tube plate, and expect by that means to make them tight. We have done this and abandoned it, as it does not deal with the root of the evil; moreover, it presents practical difficulties, especially when the time comes to retube the boiler. Sometimes a thin copper sleeve or ferule is put over the end of an iron or steel tube, and expanded with it into the plate. This frequently reduces the leakage of tubes. The explanation may perhaps be found in the fact that with a rise of temperature the copper increases to a greater extent than the surrounding material, and tends to fill up any gap which may occur. The use of internal ferules, on the contrary does not seem to affect tube leakage either way to any material extent. Internal ferules do not strike at the root of the evil. They may be used



Figs. 1, 2, 3 Different Methods of Expanding Tubes.

Fig. 4. Device to Permit Expansion in Stay-Bolts of Crown-Sheet.

with advantage, however, for the tubes which are subjected to the fiercest flame, as they interpose a resistance to the rush of flame by reducing the area of the tubes and thus cause the heated products of combustion to pass more uniformly through all the tubes.

STAY-TUBES AND WATER-SPACE STAYS.

For many years we have not used stay-tubes, and have found no injurious result. On the contrary, I believe that so far as leakage of the tubes is concerned they are bad. They are invariably thicker than the surrounding tubes, and hence more rigid than the thinner tubes alongside. If stay-tubes are used, they should be thickened only at the ends, where they enter the tube plates.

The holding power of ordinary tubes was tested by us some years ago, and we found that a 2-in. tube had a holding power in a steel plate of from 8 to 12 tons. Taking for example a torpedo boat boiler, supplying engines of 1,216 I. HP., the pressure tending to separate the tube plates at 200 lbs. steam pressure was 124 tons. The total holding power of the tubes at 8 tons each was 2,500 tons, thus showing that the ordinary tubes had a factor of safety against pulling through the plate of nearly 20.

Water-Space Stays.—Too much care cannot be exercised in arranging the water-space stays uniting the inside with the outside fireboxes, with a view to permit free expansion and contraction. In the year 1878 we built a torpedo boat for a foreign government, and had no less than eight unsuccessful trials, in every case coming home with the tubes leaking. To ascertain exactly what was going on in the region of the tube plate we removed the row of stays nearest to the tube-plate flange on the sides and top of the box. We replaced these stays by others working in stuffing boxes and having a nut on the outside, so that if a tensile strain had to be met they were there to receive it, while if the inside box wanted to expand it had freedom to do so. (See Fig. 4.)

This experiment was most interesting. Every time the fire was urged these stays would all move outward through their stuffing-boxes, owing to the expansion of the box. In some cases the movement was sufficient to enable a penny piece to be inserted between the nut on the stay and the gland. Each time the fire door was opened and the temperature reduced, these stays would move inward; and when the boiler was cool the nuts pressed hard on the glands. From the moment the new stays were fitted the boiler was altogether free from leaky tubes, and the boat was duly taken over by the Government. It is, of course, dangerous to draw a conclusion from one isolated experiment; at the same time it seems more than probable that these stays, as originally fitted, had much to do with the leaking of the tubes, because it is evident that a tensile strain coming on a tube plate, weakened by being perforated with a number of holes, is likely to distort the plate. As a matter of fact, prior to the new stays being fitted, this tube plate was more or less altered in shape after every trial. Fig. 5 shows exactly the change that took place on the first trial alone. It will be seen that between the points indicated on the diagram there was, in one case, an extension of a quarter of an inch, and in the other an extension of three-eighths of an inch. I think we may assume that tube plates should be free from external strains, and, as far as possible, be allowed freedom to move as the changes of temperature require. With a view to this we make a practice of having the first row of stays at least 7 ins. from the edge of the tube plate flange, and even these stays in large boilers are so designed as to be free to move.

Elasticity.—Special care should be taken that the flange of the tube plate is made very thin, so as to secure

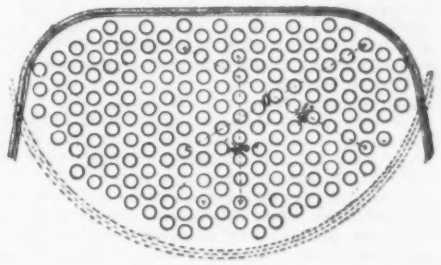


Fig. 5. Actual Distortion of Tube-Plate in Torpedo Boat Boiler by Expansion of Inside Fire-Box.

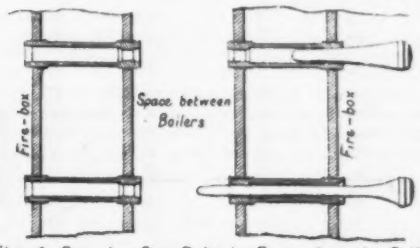


Fig. 6. Securing Stay-Bolts by Expanding with Drifts.

elasticity, and avoid strains on the tube plate itself, where the tubes pass through, also to avoid a large difference of temperature between the inside and outside of the double thickness. To insure freedom for movement the water space should not be cramped, otherwise trouble will be met with by the leaking and breaking of the stays. To gain elasticity we turn the stays down between the plates. This insures any bending of the stays being confined to the portion within the water space, and prevents movement of the stay in the plate itself, thereby causing leakage.

Hollow Stay.—A stay we occasionally use, has been designed to meet a condition frequently occcurring when several locomotive boilers are placed close together, and in consequence the stays at the sides are inaccessible for repair or renewal. It is shown in Fig. 6, and is a modification of what is adopted by Mr. PARK, of the North London Railway. In his case holes are drilled a short distance into both ends of the stay, into which a drift is forced. The stay is thus swelled out until it fits tightly into the plate, thus making a thorough mechanical job, and probably sounder work than if the stay were riveted over as usual. In the case of a locomotive, as both ends of the stay are accessible, the drift can be used at both sides. As will be seen, the new stay has been designed so as to be made tight at both ends, working from one side only. In a 1-in. stay we drill a ½-in. hole nearly all the way through, and then a ⅜-in. hole for the remainder. The stay is screwed in from the inside of the fire box, and a taper drift is passed through the larger portion of the hole and driven into the smaller, swelling the stay out, and making it a tight fit at that end. A large drift is then used for swelling out the end next the workman. By this means a stay can be put in or repaired, making it tight at both ends, the entire operation being performed from one side only. Mr. W. H. MAW has proposed to increase the diameter of the drift at the extreme end. This seems a decided improvement, as it causes the hole to be

swelled out parallel, and also enables the drift to be more readily withdrawn. A 1-in. stay with a ½-in. hole gives the same strength as a ⅞-in. solid stay. The exact strains which both these stays can resist have been carefully tested, and the results are as shown in Table I.

TABLE I.—EXPERIMENTS TO ASCERTAIN THE STRENGTH OF WATER-SPACE STAYS.

Description.	Length between plates.	Diameter of stay over threads.	Ultimate stress.
	In.		Lb.
Hollow stays screwed into plates and hole expanded.....	4.75	1 in. (hole ⅞ in. and ⅝ in.)	25,457
	4.64	1 " (" ⅞ " " ⅝ ")	20,992
Solid stays screwed into plates and riveted over.	4.80	⅞ in.	22,008
	4.80	⅞ in.	22,070

The above are taken as a fair average of numerous tests.

We have also here a water space having 1 in. hollow stays, 4 in. centres; this, when tested by hydraulic pressure, gave way at 1,650 lbs. per sq. in.

EFFECTS OF HEAT ON TUBES AND TUBE PLATES.

Tube Spaces.—The distance between the tubes should be sufficient to insure an ample supply of water to the hot surfaces and to avoid the steam being imprisoned between the tubes, especially in the region of the tube-plate, so that the heat should be carried away as soon as it arrives at the interior surface. Certainly nothing less than ⅜ in., or perhaps better still, 1 in. space, should be adopted with 2-in. tubes, when burning, say, 80 lbs. to 100 lbs. of coal per sq. ft. of grate per hour. This space will give ample room for good circulation, provided the latter be not restricted nor interfered with by any features in the design. Of late a number of unsuccessful marine locomotive boilers have been constructed with water bottoms. It may be a matter worthy of consideration whether the powerful upward current throughout the water space round the firebox is not the means of drawing from the lower part of the barrel a large quantity of water, thereby robbing the tubeplate of a portion of the supply which it would obtain if there were no water bottom.

Length of Tubes.—The length of the tubes should be of such proportion to their diameter as will insure elasticity. For this reason large tubes or short ones are objectionable, as they are too rigid.

Alteration of Tubes when Raising Steam.—We carried out a very interesting experiment to ascertain exactly what was happening to the tubes during the process of raising steam and also when at work. (See Fig. 7.) It will be seen that through three of the tubes, which are at different levels, there are fitted three bars; the latter are fixed at the end next the fire, and also in the center of the tube. The object of this experiment was to ascertain if the tubes remained straight, and, if not, to register the extent of the bending, which would be made apparent by the alteration in the position of the extreme ends of the rods. Almost immediately after lighting up it was found that the top row of tubes was evidently heated in advance of the rest. The hotter water, as might have been expected, was near the surface, the cold water at the bottom remained undisturbed, and the top of the boiler was also cold, owing to there being no steam to heat it. The water near the surface being raised in temperature, those tubes which passed through it strove to increase in length; but, owing to the tube plates being fixed, they were unable to do so, consequently there was a considerable bending of the tubes. This was made evident by the movement of the end of the rod. After the fire had been alight about 10 minutes the second bar began to move as the water at the lower level rose in temperature. In like manner, after a further interval, the third bar moved, and the bars all continued to move until such time as steam began to rise. As soon as a pressure of 10 to 15 lbs. was registered, the pressure on the tube plates began apparently to make itself felt, and forced them apart, throwing a tension on the tubes which straightened them.

From that point up to 160 lbs. the tubes showed practically no curvature. This experiment proves how necessary it is to provide ample elasticity in the tubes so as to conform to the conditions existing when raising steam.

Distortion of Boiler while Raising Steam.—The strains which boilers have to withstand when lighting up are well-known to be very serious and of an entirely different character, and in some parts far more severe than those met with when at full work. As evidence of the strains caused by unequal expansion when lighting up, I would refer you to Table II. and Fig. 8. With a view to reduce these strains and increase the temperature of the boiler as uniformly throughout as possible when raising steam, we make a practice, in the case of a large boiler, of filling it quite full, and, as the temperature rises, allowing the water to run out from the blow-off cock, so that by the time steam shows itself the water is at the working level. In this way the upper part of the boiler is warmed up and the cold water at the bottom is got rid of. In cooling down, the strains are not so great and are quite different in character from those met with in lighting up.

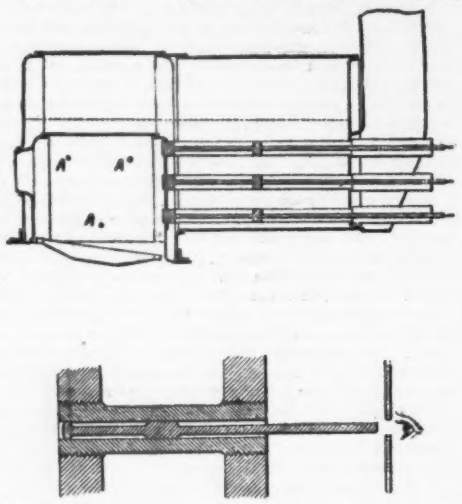


Fig 7. Experiments to Determine Movements of Tubes when Raising Steam.

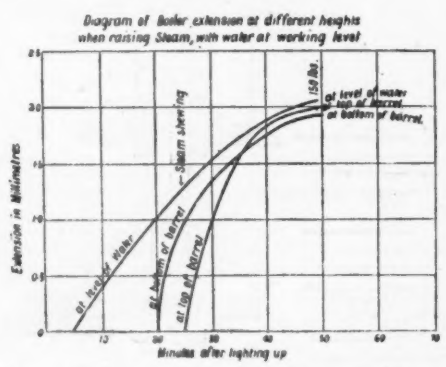


Diagram of Boiler extension at different heights when raising Steam, with water at working level
Expansion in Millimetres
Minutes after lighting up
150 lbs.
at level of water
at top of barrel
at bottom of barrel
Steam showing
at level of water
at bottom of barrel
at top of barrel

Fig. 8. Diagram of Boiler Expansion at Different Heights when Raising Steam.

TABLE II.—EXPANSION OF OUTSIDE SHELL OF BOILER WHEN RAISING STEAM. LENGTH, = 1028 MM.

Lit up at 10:20 A. M. 4 ins. over fire-box.

Time....	10.30	10.40	10.50	11.0	11.10	11.20	11.30	11.40	11.50
Steam, lbs....	0	0	0	0	0-5	20-40	60-80	100-120	140-160
Boiler shell at water level...	.2	.6	.8	.9	1.4	2.0	2.5	2.7	2.8
Top.....	0	0	0	.4	1.6	2.0	2.5	2.5	2.8
Bottom..	.2	.3	.4	.8	1.6	1.6	2.5	2.5	2.5

Elongation of tubes in mm. Length of tube = 1168 mm.

Top tube	1.5	1.6	1.6	1.6	2.5	2.7	2.4	3.2	4.0
Bot'm "	.7	.9	1.5	1.5	2.0	2.5	2.9	3.6	3.6

One main principle must be borne in mind: That any changes of temperature must take place as slowly as possible. Sudden pulling out of the fire is, therefore, bad. Especial care should be taken in the annealing of the tube plate to reduce changes of form when the boiler is first set to work. This annealing should, of course, be done when the plate is flanged, and possibly it might be desirable to do it after the tubeholes are drilled, leaving a trifle to be rimered out finally.

Starting New Boilers.—An ordinary brick furnace when new is heated up very slowly, otherwise it cracks and falls to pieces. Were the same consideration extended to a steam boiler it would often avoid trouble by allowing the various parts to accommodate themselves to their new condition by slow degrees. Many trials have failed through anxiety to work up boilers to their full power too quickly.

Boilers when new, however, frequently give more or less trouble from leaky tubes at the commencement of trials. To this we do not attach much importance, provided it is due to unavoidable changes of form, which are temporary. It need not be looked on as of serious moment, as the leakage will soon disappear. Very frequently the tubes leak on cooling down, and if this happen only to a small extent it deserves little attention. Probably the best thing to be done is to leave the tubes alone. Often people take fright at this small leakage and start re-expanding, unnecessarily punishing the tube.

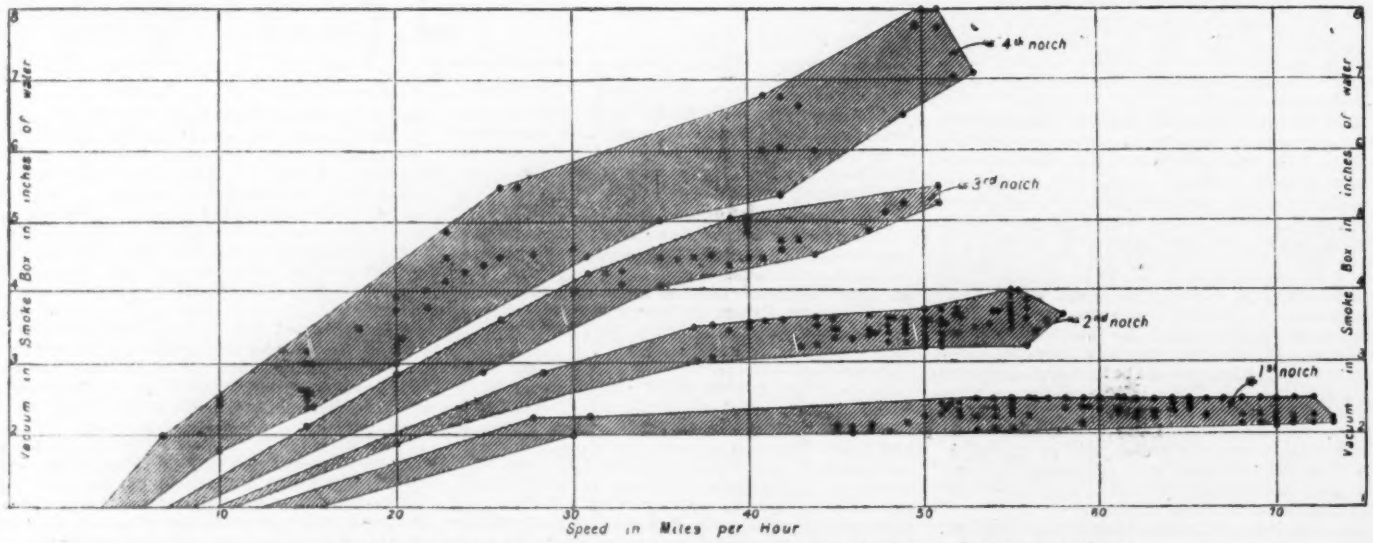


FIG. 9. SMOKE BOX VACUUM OF LOCOMOTIVE AT VARIOUS SPEEDS, MIDLAND RAILWAY.

AIR PRESSURE.

In the passage of the air from the stokehold to the funnel, the greater part of the resistance to be overcome in most cases is due to forcing the air through the tubes; consequently, if a contractor be limited to a given amount of air pressure, the only means he has open to meet this condition without extra weight is by augmenting the diameter of the tubes or reducing their length, thus producing rigidity, which, I have already pointed out, is bad.

Because a certain boiler does not stand a given air pressure without the tubes leaking, only proves that that air pressure is too much for that boiler, but does not prove that this air pressure is too much for every boiler; especially in face of the fact that locomotive engines are working all over the world at air pressures varying from 3 ins. to 8 ins. Fig. 9 shows the vacuum in the smokebox of a locomotive of the Midland Ry. at various speeds. In confirmation of the high air pressure used on locomotives I cannot do better than quote the following statement of a locomotive engineer of one of our leading lines:

"We do not consider from our experiments that a vacuum of 8 ins. in a smokebox is anything exceptional, but should expect it when working full power, either going up a bank or drawing a heavy train on a level. In addition to the vacuum in the smokebox we register a pressure of air in the front of the ashpan, due to the speed of the train, of 2 ins. of water, making a total air pressure of 10 ins."

With these facts before us, there ought surely to be no condition imposed upon the marine engineer limiting the air pressure. Would it not be good policy to leave the hands of the designer and maker free to adopt whatever air pressure he likes, so long as he gives security that the boiler he supplies will stand it? It is surely better to adopt a high air pressure and have a trustworthy boiler, than to limit the air pressure and have a boiler which at any unexpected moment may give way altogether; in other words, a low air pressure involves a rigid boiler, and a rigid boiler is not trustworthy. I think that we may fairly conclude that, by limiting the air pressure, the very best possible inducement is held out to supply a bad boiler, because it leads to a rigid one. If it be wished to limit the temperature of the furnace, which I am ready to admit is desirable, I submit that this may be better effected by limiting the rate of combustion.

(*To be Continued*).

On the Advancement of the Profession of the Civil Engineer.*

It is provided in the constitution of many engineering and other scientific societies that the president shall deliver an annual address, the fundamental law of some of these bodies also prescribing the subject matter of the address to be presented.

Our own society has no such provisions in its constitution, and it thus remains optional with the president what manner of address he will deliver, or, indeed, whether he will deliver any. But the custom has grown up that the president, by the delivery of an annual address, may fitly show his appreciation of the honorable office his fellow members have conferred upon him—a custom which I gladly follow, and, as the subject matter has thus been left entirely free to the choice of the president, I take the occasion to select one which is very dear to me: "The Advancement of the Profession of the Civil Engineer," more especially in this country.

We are met at the beginning of our consideration of this subject by the question whether it has been rightly named. Is the civil engineer a member of any of the learned professions, or does he not rather follow a trade, or perhaps, a calling, of a somewhat lower ethical standard than those ordinarily called professions? And it may be instructive in this connection to endeavor to define just what constitutes a profession, and what a trade or occupation, these words being taken in their current meaning.

This is a branch of the subject upon which I have often pondered until the difference between the two things named has at last become clear to me, as so often happens, by looking at them from their sentimental or spiritual side only. My conclusion has been that the difference between a trade and a profession is gaged by the amount of confidence voluntarily reposed or deposed for the time being by the employer in the employed. The conduct of mankind in its dealings with the employed gives these employees their standing, whether as men of a certain profession or as following only a certain trade, and the touchstone of such conduct is the amount of confidence that is voluntarily given by the one to the other.

No lawyer is an honored member of an honorable profession, who does not spontaneously command, and as spontaneously receive, the entire, the closest confidence of his clients. Observe how quickly men practicing at law change from members of a profession to men passing by various opprobrious epithets, and to mere parasites upon society, so soon as men do not freely give them their whole confidence. The confidence given must be given spontaneously, and can not be solicited. If not received spontaneously, it can not be otherwise procured, and from failing to receive that of his clients, such so-called lawyers soon fail to receive that of any members of the community, and become members of anything but a profession.

Can any one imagine a member of the medical profession, except he be given the confidence of his patients?

I presume the only reason why veterinary surgeons, whether of a royal college or of a lower educational standard, and—they will pardon the conjunction—why even dentists have such up-hill work in being considered members of a profession is that their duties call for so limited an amount of the confidence of their clients to be placed in them. The more valuable the work done by them, the more confidence reposed in them prior to that work, the more they, too, will be considered members of certain branches of the medical profession. Doctors, finally, who go about soliciting the confidence of their fellow men speedily become quacks.

Ministers of the gospel and heads of other religious bodies naturally receive the full confidence in certain directions, of their parishioners, and by that act become members of a profession. If this confidence be not given them spontaneously, then they, too, cannot, to such as do not give them this, their entire confidence, appear as members of any of the learned professions.

So that it may be said that by reason of the amount of confidence evoked from their fellow-men, throughout the centuries that have passed, these three, law, medicine and theology, have been considered the three learned professions; and, in a measure, it remains to be seen whether in these United States of America these three can or can not retain a monopoly of that appellation.

This difference between the professional employee and the hireling, between the "friend" and the "servant," as it is there written, may be found laid down in Scripture: "For the servant knoweth not what his lord doeth." A servant is told to do a certain thing and does it, not being consulted as to knowing, or caring for, the reason why, and is a servant; while the friend or member of a profession has given him his employer's entire confidence, is consulted on every phase of the subject-matter and himself carries the responsibilities of the situation to the fullest extent.

I think I have illustrated my argument sufficiently to make clear that, in the measure that civil engineers will have given them the confidence of their employers, they will act as members of a profession, or else of a trade or calling.

The advancement of the profession of the civil engineer in this country is then a difficult thing to accomplish by the designed efforts of men. As in many another social question, causes and effect react upon each other, and the education of a whole community is necessary for the purpose held in view. In certain of the European countries, civil engineers have always been placed in positions of palpably greater responsibilities than is the rule in the United States, and I doubt if the question of their being members of one of the learned professions could there have ever been properly raised.

We have the statement of the President of the American Society of Civil Engineers to the effect that he is anxious to see raised to a still higher plane the position that engineers take in this country, "which," says he:

> In my judgment is as yet inferior to the position they hold abroad, and the position which I feel sure they will attain in the future. One of the pleasantest features of the trip of the American engineers to Europe was in observing the respect, the honor, with which engineers are treated abroad. Not only do they receive very much better compensation than in this country, but they are looked upon as at the head of the industrial movements, without whose assistance no great scheme can be carried out. Among the first visits which we paid while in London was one to Westminster Abbey, and there we found monuments to engineers by the side of the great warriors and statesmen that that country has produced. In the picture galleries the pictures of engineers were hanging upon the walls. We find long aisles in the Crystal Palace filled with busts of these engineers.
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> When the fact was known that we were American engineers the doors of welcome were opened wide to us all through Great Britain, and when we arrived in France we found that a civil engineer was one of the Ministers of State and another the President of the French Republic. When he met the American engineers he told them that he received them, not only as Americans, but as his comrades, and the mere fact that they belonged to that profession was a passport to them, not only to all the places of interest which they wanted to visit, but also to all social entertainments, and they came away—the whole 300 who paid that visit last year—with the most gratifying impression of the high social position which our profession occupied abroad, and with the hope that, by strong efforts to raise the standard in this country, a similar recognition might be obtained here.

To this, all who are acquainted with the life of the profession anywhere in Europe, can bear concurrent testimony. The accomplished Mayor of Geneva, Switzerland, is a civil engineer, elected as such, after having completed a notable engineering work for his native city; and for the design of the Liverpool water-works, an honored member of the profession is reported to have recovered in the courts over $100,000 not long ago, upon his not being retained in charge of the work thus begun by him.

Although these are merely straws that show which way the wind blows, I do not remember to have read the like items in the newspapers, in which the scene was laid in the United States.

The position in the body politic, and in the community, of the civil engineer on the continent of Europe is something that must be seen and felt on the spot in order to be thoroughly appreciated. He is there a marked member of the community, having distinct functions and duties. Where we appoint committees of butterfly existence to report, or even to execute engineering works, a French or German township, or county or State, will act as would a well-organized American city, having a city engineers' department, or, better still, a board of public works; or will appoint a committee consisting of engineers only. Those of our citizens who go abroad come back delighted with the results of the well-regulated systems of carrying on the public works which they see, as, for example, magnificent bridges, perfect roads, a *general* impression of neatness, order and good work; but the engineers of this country have done fully as well, whenever they have been given opportunity. And it is plain that to reproduce the appearance in this country of the engineering works which these gentlemen find so delightful abroad, they have but to consider that like causes produce like effects, and give opportunity at home to an equal extent to the followers of that art which builds these works.

In defining what constitutes the profession of a civil engineer, we probably will never improve on those grand words of the charter of the Institution of Civil Engineers, of Great Britain, which speak of it as "being the art of directing the great sources of power in nature for the use and convenience of man." It may be but natural that so wide a domain should with difficulty be kept free from the encroachment of all sorts and conditions of men other than civil engineers. This seems to be especially true in England, the parent country, and its colonies, and in the United States, its offspring. The politician, the lawyer, the teacher of youth, the military engineer, savants of various degrees of childlike simplicity and of impractability, the citizen at large, the old-time driver of a four-horse stage coach, all pose, from time to time, in the eyes of the public, as practicing civil engineers, and proceed improperly to direct the labors of the civil engineer. Hovering about the profession, yet not of it, are contractors, promoters and other such seekers of mammon first, and of "the art of directing the great sources of power in nature for the use and convenience of man." Afterwards, while closely connected with the profession, and yet not in itself constituting it, are land and hydrographic surveyors, map makers and the like. After such a review of the situation let us not despair. There is, after all, or is to be, the profession of the civil engineer; and other professions have, too, their poachers and their quacks.

Take, for instance, the medical profession, and observe its enemies and parasites as such. Not to mention grandmotherly remedial agencies, consider the great array of patent medicine compounders and vendors, quacks of every name and nature, from the faith healer of the cities, to the four white horse and brass band charlatan of the country towns. Think of the great army of apothecaries, even yet sometimes individually called doctors, and take courage in the fact that there is nevertheless a medical profession. The parallel between apothecaries and surveyors has always seemed to me a neglected point of knowledge to the general public. Stated in arithmetical language, we might put it, that, as apothecary is to doctor, so is surveyor to civil engineer. A doctor must know the apothecary's art, as the engineer must know all about surveying, but neither need especially practice his respective subordinate calling, and the general public should be taught to recognize the difference between the two. It is for the reasons here touched upon, because the difference between surveying and civil engineering was slurred over, instead of having been accentuatad, as it should have been, that many engineers in the United States have always deeply regretted the choice of badge made by the Am. Soc. C. E., which is a levelling instrument on a blue field. Rather than to confirm the general public in its notions of the equality of the two occupations, it should have been taught their difference on an occasion like this. Instead of placing on its badge "something of the earth, earthy," the badge should have borne a conventional figure, typical of the art of the civil engineer. Had the levelling instrument been of a bye-gone age it might have figured as appropriately on the badge of the Am. Soc. C. E., as do the crossed hammers on the badge of the Am. Inst. of Mining Engineers; but under existing circumstances the choice made, originally at the instance of an ordnance officer of the United States Army, can hardly be said to have contributed to the advancement of the profession of the civil engineer, "being the art of directing the great resources of power in nature for the use and convenience of man."

We have seen something of the position of the civil engineer in communities living under minutely regulated forms of government, such as France, Germany and other continental countries. That our own present status is but a forerunner of the same general standing of the engineer in the United States, many signs seem to indicate. Time was, not so very long ago, when there could hardly be said to have been such a thing as an architect abroad in the land. Most of us remember the modest signs: "Architect and Builder" following those of "Carpenter and Builder," or of "Mason and Builder," and only recently followed by those of "Architect."

Time was, not so very long ago, when cities had no city engineer, only a city, or, possibly, only a country surveyor, or no official representative of the engineering profession whatever among their officers. Such is the condition of affairs in counties, in States and in the United States, even now. Yet there can be no good reasons cited why the execution and the care of the public works of the county, of the State, and of the body of States, should be in any more heterogeneous condition

* An address delivered before the Boston Society of Civil Engineers by CLEMENS HERSCHEL, President of the Society.

than is that of the cities, and there are signs that seem to indicate the coming change. Thus, counties and States are agitating the subject of better road-making, and with consideration of the subject comes the conviction that to have a thing well done, it must be somebody's business to do it; and we begin to hear of county road and of States road engineers. Certainly the existing method of letting ignorant men annually plow and shovel up the road washings from the gutters back into the middle of the road, and so on *ad infinitum*, while a fair way of producing mud and dust, and a lazy man's method of frittering away the public funds among a set of lazy men, who possibly have contributed some share of them; while an excellent method of how to accomplish no good, will never make roads fit to be called roads, and when pursued by each town at its own sweet will, becomes a system as barbarous and disgraceful as may well be conceived, following a study of how good roads are built and maintained throughout those countries that have them. It is an encouraging sign that the great States of New York, New Jersey and Pennsylvania, as well as others in the south and southwest, are simultaneously moving in the matter of better roads throughout their respective territory—even though this agitation comes now, full twenty years after our own commonwealth of Massachusetts made a move in the same direction. To have better roads must and will call for wiser road legislation; and with wiser road legislation will come a call for the civil engineer to build and maintain those better roads; to that extent will come some advancement of the profession of the civil engineer.

(To be Continued.)

A California Flume for Transporting Lumber.

The building of timber flumes to convey streams of water is an art which has probably been practised more extensively in California than in any other part of the world. First, to supply the great quantities of water required for hydraulic mining, and afterward to supply the still greater amounts required for irrigation, it has been necessary to build artificial channels to convey the water without waste from its sources high in the mountains, to the dry valleys and plains below. As timber is remarkably cheap and easy to get, while the reverse is true of iron work, open wooden flumes have been used for the conveyance of water wherever possible. The widespread use of wooden flumes for these purposes has led to their use for other purposes; and we have at hand some notes of a timber flume 52 miles in length in Fresno Co., Cal., built last year for the purpose of conveying lumber from a point in the Sierra Nevada Mountains, nearly at the line of perpetual snow, to the plains below.

The flume was built by the King's River Lumber Co., with Mr. J. M. GRAHAM as Chief Engineer. It is of V-shaped section, the apex being a right angle, and at the head it is 3 ft. 7 ins. across the top and 21 ins. deep. This width is increased at various points, as a decrease in the grade makes necessary a larger volume of water to float the timber, and at the lower terminus it is 5 ft. 4 ins. across the top and 31 ins. deep. It receives its main supply of water at the head from Lake Sequoia, and there are four feeders at various points along the line which make up for the loss by leakage.

The flume is built of 1¼-in. boards, and the details of its construction are very well shown in Fig. 2. It is supported on trestle work, which, in crossing some of the deep cañons in the mountains is as much as 130 ft. in height. The upper 27 miles of the flume required over 5,000,000 ft. of lumber, most of which had to be "packed" on men's shoulders to its place of use. The lower 25 miles, most of which follows along the valley of King's River, required about 4,000,000 ft. of lumber. We have been unable to obtain the exact grades of the line, but understand that at one of the steepest places, about half a mile below the head, the flume has a grade of nearly 23%, or 1,200 ft. to the mile; this astonishingly steep pitch being maintained for about 1,000 yds., giving a total fall of nearly 750 ft.

In view of this steep incline it may be somewhat surprising to learn that the flume is made use of to transport not only lumber but passengers and freight. As already stated, roads are few or wanting entirely in the rugged district from which the flume leads; and its swift current has therefore been utilized to furnish rapid transit. It need hardly be said, however, that the trains on this rapid transit line run in one direction only.

The "boat" for the carriage of passengers or freight is a V-shaped box, about 16 ft. long, roughly knocked together with boards, since it is "good for one trip only." The front end is left off, as the velocity of the water is such that it will not run back into the boat to any extent, while the water that comes in through the cracks is free to run out. A plank is placed along the bottom, and on this the passengers rest their feet, sitting single file on cross-seats. When all is ready, the spikes by which the boat is held while loading up are pulled out, and away it goes on its 52-mile journey, the upper part of which, in coming down the steep grades, is described as a most exciting experience.

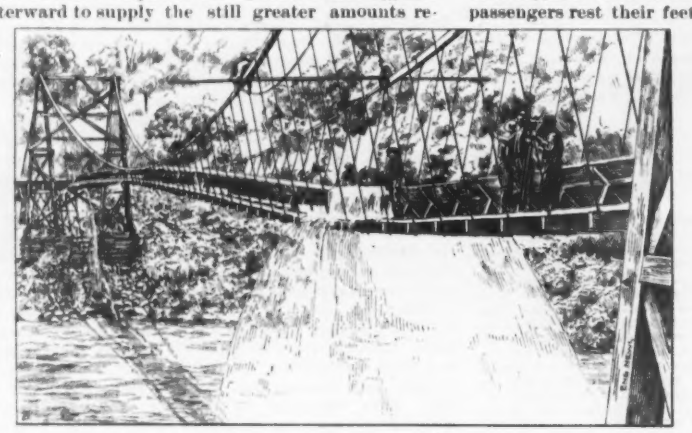


FIG. 1. TRYING A SUSPENSION BRIDGE FOR A LUMBER FLUME WITHOUT A STIFFENING TRUSS.

FIG. 2. SUSPENSION BRIDGE CARRYING FLUME OF KING'S RIVER LUMBER CO., ACROSS KING'S RIVER, FRESNO CO., CAL. Built by Pacific Bridge Co.

An interesting piece of engineering work, in connection with the flume, is the suspension bridge by which the flume is carried across King's River. It is illustrated in the accompanying engravings, made from photographs furnished us by Mr. F. A. KOETITZ, of the Pacific Bridge Co. Mr. KOETITZ describes the structure and a curious experiment that was tried in its erection as follows:

The bridge was built by the Pacific Bridge Co. of San Francisco, and was completed in June, 1890. It is 451 ft. long between towers, and has seven 1⅝-in steel cables on each side. These are covered with wooden boxes, as shown, to protect the cables against expansion due to extreme heat. The bridge has a grade of nearly 1%, or 4 ft. 5 ins. in the length of span.

Although the writer claimed that the wooden flume could not be built across the bridge successfully without a stiffening truss, the owners would not agree to have it done by the Bridge Co., claiming that they could build the truss cheaper themselves, if it really should be necessary. The bridge was for that reason built first without a truss. After a great deal of trouble they did succeed in building the lower section of the flume across;—a 16-in. board at each side of the V. The complete flume consists of two 16-in. boards, and one 10-in board, at each side of the V. They now tried to run the water in this lower section only, and although there was a succession of short waves for the full length of the bridge, they succeeded in getting some of the water across the bridge.

Encouraged by this, they completed the flume, as stated above, and started to let the water run across, with results which were quite unexpected to them, and which may be understood by reference to Fig. 1. When the water was let in at the head, even in a small quantity, it naturally caused a slight deflection of the first half of the bridge and raised the other half. This deflection, of course, caused a rapid increase of water at the place of greatest deflection, on account of the V-shape of the flume. The deflection would continue to increase as the water accumulated, until it amounted to 3 ft. 6 ins., and the water ran over the sides of the flume.

The spilling of the water over the sides of the flume would prevent any further deflection, and a reaction would set in. The water would run slowly over the center, loading the other half of the bridge, and would have a tendency to equalize the load. The first half would now rise a little, assisted by its reaction; the second half would deflect accordingly; the water would commence to run faster over the center; the area of water would increase rapidly at the lower half, and would deflect and act in the same manner as the first half had done, until it deflected 3 ft. 6 ins. and the water ran over the sides, while the first half was raised above the grade line. This position of the bridge is shown by Fig. 1. Then the lower half of the bridge would begin to rise as the spilling of the water relieved it of weight, and the first half would begin to deflect until the water ran over there, as at first. This oscillating action would continue at regular intervals of 1 minute and 40 seconds until the water was turned off at the head; then, after the water had run out, or leaked out, the bridge would come back to its original position.

The bridge would, no doubt, have deflected much more if the sides of the flume had been still higher, and had allowed a greater load to accumulate, although a limit is reached, of course, at the greatest distortion of the cables.

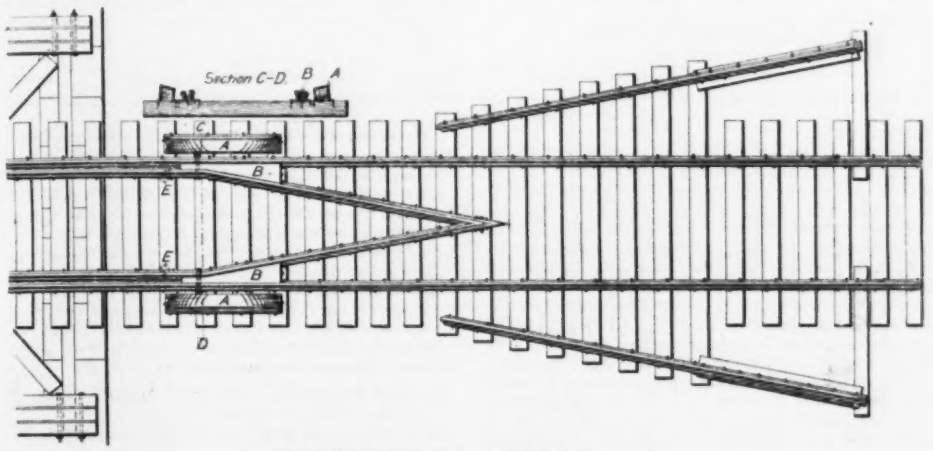
It could be easily seen that the center part of the span acted as a fulcrum, around which these deflections took place. The span at the center could not deflect much; it could only change its position a little longitudinally, and this was evidently the cause of the wave motion occurring at such regular intervals.

The reason that water could be run across the bridge through the lower section of the flume before the upper boards were put on is easily found in the fact that not enough water could accumulate at any particular point to cause a great deflection. It had to run over the sides and in that way act as an equalizer. A box flume with vertical sides might have acted quite differently.

It is perhaps needless to mention that, after the Bridge Co., being called upon, put in a stiffening truss, as shown in Fig. 2, not the slightest trouble was experienced, even under heavy concentrated loads, such as those produced when a "boat" crosses the bridge by the damming up of the water behind the boat and its lowering for some distance in front.

The Cleveland Bridge Guard.

The rerailing guard shown in the accompanying illustration has been brought out by B. E. Tilden & Co., of Cleveland, O., and is an adaptation of their wrecking frog to a bridge guard. On the outer side of each track rail, and 3 ins. from it, is a rerailing frog *A*, about 4½ ft. long and 7 ins. wide. The upper part is at least 1 in. higher than the head of the rail and about 2 ft. long, sufficient to allow of a wheel being effectually drawn over by the opposite guard rail or by gravity, the surface of the frog being inclined toward the rail, as shown in the cross-section, so that a wheel will ride upon the edge of its tread. The ends of the frog are curved. Between the inner guard rails and the track rails are the inclined planes, *B*. The distance between the guard rails and track rails is 2 ins. at the narrowest point. When a derailed truck reaches the guard the inner wheels run up the inclined plane *B*, and are pulled over to the track rail by the inner guard rail, and in this way pull the outer wheels, which are riding the frog *B*, down the sloping surface of the frog on to the track rail. The frog may be made



THE CLEVELAND RERAILING BRIDGE GUARD.

solid, or may be a metal shell with a wood filling, as shown. The guard rails, which, of course, are not covered by the patent, may be arranged to suit individual ideas. The inner guard rails may be continued across the bridge, or may stop just beyond the rerailing device, as shown by the dotted lines. The illustration shows outer guard rails on the approach.

The Central London Ry.

From a personal letter recently received from Sir BENJAMIN BAKER, we make the following abstract relating to the plans of the Central London Ry.:

The Southwark subway, now called South London Ry., has proved a perfect success in working, both as regards electric motors and hydraulic lifts. There were a few small mishaps at first, from short-circuiting chiefly, but all goes well now with a 4-minute train service.

As a result of this success a bill has passed the House of Commons for an important line down Oxford St. from Shepherd's Bush to the Mansion House, a distance of 6 miles, through the most valuable part of London.

The trains will consist of 6 cars, somewhat larger than the "elevated," seating, in all, 336 passengers, and weighing, with the electric motor, 120 tons. The speed will average 14 miles, including stops, the maximum being 25 miles. The motors will develop 300 HP. at 13 miles, and somewhat less, of course, as the speed increases. From experience on the South London Ry., it is believed that the average electric horse power of motors required for this speed is 1 HP. for every ton of train. In this case, with 18 trains of 120 tons, 2,160 HP. will be necessary. The maximum horse power will be about 50% greater—say 3,000 HP.; and, at 60% efficiency this means that the horse power required at the generating station will be 5,000. This will all be developed at one end of the line.

The line will be far below all sewers and pipes, and so avoid complaints of vibration and damage to property.

The Present Status of the Philadelphia Water-Works.

In view of the fact that the annual meeting of the American Water-Works Association is to be held at Philadelphia next week, the following information regarding the present status of the water-works of that city will be of especial interest. The facts presented are taken from the report, just published, of Mr. LOUIS WAGNER, Director of the Department of Public Works. No attempt is made to sketch the history of the works or describe them in detail, because this is to be done by Mr. E. GEYELIN in a paper entitled "The Beginning and Growth of the Philadelphia Works," which will be read at the meeting already named, and because it has been already done both in this journal and THE MANUAL OF AMERICAN WATER-WORKS.

The total pumping capacity of the Philadelphia water works is 185,200,000 galls., of which 33,200,000 galls., or over one-sixth, is water power. The total reservoir capacity is 869,288,814 galls. There are comprised within the system 900 miles of mains; and 181,034 premises, out of a total of 195,588, or about 93%, are supplied with water. There are but 522 meters in use.

The total consumption of water in 1890 was 50,273.9 million gallons. Of this amount 1,424.6 million gallons was repumped, making the total pumpage for the year 51,698.5 million gallons. Of the total pumpage 12,363 million gallons, or somewhat over 25%, was pumped by water power, requiring to drive the turbines 370,889.6 million gallons, or over 30 gallons for every gallon pumped.

The following table is interesting as showing the cost of pumping and rapid increase in the rate of consumption during the last four years:

Year.	Pop'l'n*	Consumption per. day, galls. Av. per. cap.	Inc. per cap.	Total yearly inc., million galls.	Cost per million gals. raised 100 ft.	Increase or decrease cost of raising one million gals. 100 ft.
1887	995,000	89	9	3,767.8	$3.99	— 14 cts.
1888	1,020,083	100	11	4,642.0	4.49	+ 50 "
1889	1,050,000	110	10	5,450.0	3.87	— 62 "
1890	1,046,964	131	21	9,179.6	3.05	— 82 "

*1890, U. S. Census; other years estimated.

The increased consumption is much more startling when it is stated that it has increased from 68 galls. per capita in 1880 to 131 at present, or from a pumpage of 21,120.8 to 51,698.5 million gallons, a total increase of 30,577.7 million gallons. In other words, the per capita consumption nearly doubled in 10 years, and the total pumpage has doubled once and nearly half again. Meanwhile the population has increased from 847,170 to 1,046,964, or less than one-fourth. But it is quite probable that the percentage of population actually supplied with water is much larger now than in 1880, and that the proportion of large consumers has increased more rapidly than the population.

The total receipts from water, fines, etc., in 1890 was $2,381,038, against $1,484,375 in 1880, an increase of $895,681, or about 60%, against an increase of 145% in consumption. The current expenses in 1890 were $712,497, and the expenses for extensions $280,867, making a total of $993,364, and leaving a balance of receipts above expenditures, without an allowance for interest, of $896,603.

The Accident at the Sault Ste. Marie Canal.

The break in the coffer dam of the new Sault Ste. Marie Canal, in Michigan, has been described as follows in the Detroit *Free Press*, as the result of an interview with Col. O. M. POE, U. S. Engineer, who is in charge of the work:

The break was first discovered March 18, the water coming through a part of the dam where there had never been a break before, but which has been in position for the past 2 years. The stream when discovered was about the size of a man's hand, but at 5 A. M. on the 19th it came with a rush, entirely filling the lock-pit to the depth of 40 ft., submerging the machinery of the contractors, and flowing out of the lock-pit at the lower end where the dam is 5 ft. high. The lock-pit filled in about 10 hours after the rush set in, and now contains about 40,000,000 galls. of water. The crib work of the dam is intact, it being uninjured so far as we can see, but for 50 ft. all the clay has been washed out and there is an immense hole under the crib work. The dam is built on a rock bottom, where piles could not be driven, and consists of two parallel lines of crib work, the cribs filled with stones and supporting or shielding the dam proper which consists of an 8 ft. bank of clay. The cribs are each 20 ft. wide, and with the clay middle section, make a structure 48 ft. in width. The depth of water where the break occurred is 28.9 ft. All the men and teams available were at once set to work hauling clay, but bags of clay and bales of hay thrown into the break were washed through like corks. A pile-driver was then procured, and 2 × 12 in. planks driven along inside the inner crib. These caught the bales of hay and bags of clay and retained them in position, and by this means about half the inflow was stopped. The sheet piling was stopped by some hard substance, possibly a large section of frozen clay—the soil is everywhere frozen to the depth of 5 ft.—and, although shod with iron the piles were broken before reaching anywhere near to the bottom. A heavier pile-driver was then used to drive timbers 12 × 12 ins., sharp pointed and shod with iron. The loss will have to be sustained by the Government.

Proposed Building Laws.

Representatives of the American Institute of Architects, the National Association of Builders the National Association of Building Inspectors, the National Board of Underwriters and the National Association of Fire Engineers recently met in New York, and recommended the adoption of the following regulations as part of the building laws in large cities:

That all buildings over 70 ft. in height be constructed throughout of incombustible materials, protected in the most approved manner for resisting fire.

That interior structural iron work in all buildings be covered and protected by fireproof material.

That all buildings over 50 ft. in height be furnished with permanent stand-pipes and ladders for the assistance of the fire department.

That the height of buildings to be erected should not be more than 2½ times the width of the principal street on which they are located, and that no building or portion of a building, except church spires, should be more than 125 ft. high in any case, except under special permit.

That the open floor-space not divided by walls of brick or other incombustible material, in all buildings hereafter erected for mercantile or manufacturing purposes, should not exceed 6,000 sq. ft., without special permission based upon unusual and satisfactory precautions.

That every building which shall be 3 stories high or more—except dwelling houses for one family—and which shall cover an area of more than 2,500 sq. ft., should be provided with incombustible staircases, inclosed in brick walls at the rate of one such staircase for every 2,500 ft. in area of ground covered.

That wooden buildings erected within 18 ins. of the boundary line of the adjoining property should have the wall next to the adjoining property of brick; or, when built within 3 ft. of each other, shall have the walls next to each other of brick.

Legal Decisions of Interest to Engineers.

Right of Way for Telegraph Company.—In a proceeding under Act. Miss., March 16, 1886, to condemn a right of way for a telegraph and telephone company over a railroad right of way, witness for petitioners stated that the land to be occupied by the posts was worth from $2.50 to $3 per mile, while experts for defendant said it was worth to the telegraph company $100 per mile. The commissioners fixed the amount at $40 per mile. Since it did not appear that "the commissioners acted upon testimony that was irrelevant or incompetent, and that their award was contrary to law, . . . and that injustice had been done, ' the award would not be disturbed. (Postal Tele. Cable Co. v. Ala. & V. Ry. Co., Supr. Ct. of Miss., 8 South Rep. 375.)

Injury from Defective Tracks.—A section foreman, who in being carried over a part of the road which he is not required to inspect or repair, has a right to assume that it is in a reasonably safe condition, and he does not accept risks occasioned by defects of which he has no knowledge. It is not an error to charge that, if a railway company "permitted its tracks to become so defective and out of repair as to render running of its trains more dangerous

to its employees than it was reasonable and proper for it to be," it was liable; and to refuse an instruction that the company was bound only to exercise reasonable and ordinary care to provide a safe road. The sectionmen connected with work trains having habitually ridden in the caboose or on the flat cars as they pleased, and the company having so carried them without objection, it is not error to refuse an instruction that riding on a flat car is contributory negligence, if it is more dangerous than riding in the caboose. (Supr. Ct. Tex., 14 S. W. Rep. 918.)

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Bristol.—Local papers state that work will be resumed on this Vermont railway as soon as the frost is out of the ground.

Lake Erie, Essex & Detroit River.—This Ontario railway is to be extended from Leamington to Simcoe, Ont.

New Albany Belt & Terminal.—It is expected to have the new belt railway at New Albany, Ind., opened for traffic by May 1.

Deerfield Valley.—It is stated that the money necessary to secure the construction of this Vermont railway has been secured, and that work on the preliminary surveys has already been begun. The line will run from Readsboro to Wilmington, Vt., 14 miles. Construction will commence soon.

Projects and Surveys.

Indianapolis, Logansport & Chicago.—A correspondent sends us the following:

The surveys for this road will be commenced about June, 1891. The road is to run from Indianapolis to Logansport, Ind., a distance of 68 miles. The route is through a fine agricultural section, affording easy grades and curves. The principal business of the road will be in agricultural produce, wood, coal and lumber. The officers are: President, E. N. Talbott; Secretary, Chas. H. Jeffries, and Chief Engineer, Walter A. Osmer; all of Logansport.

Bangor & Aroostook.—At a meeting of the projectors of this road held recently, the following officers were elected: President, A. A. Burleigh; Treasurer, B. B. Thacher; Clerk, F. H. Appleton, and directors, J. P. Bass, C. F. Bragg, Chas. A. Gibson, Edward Stetson and Edward L. Stewart.

Delaware Terminal.—A bill has been introduced in the Delaware Legislature, chartering a railway company by this name. The road is to run from Lewis, Del., to a point on the New Castle Co. line in Maryland.

Georgetown, Milton, & Delaware Bay.—This road is projected to run from Georgetown via Milton to a point at or near the mouth of the Broadkiln River.

Exeter & Amesbury.—This company has been chartered in New Hampshire to build a line of railway.

Mt. Carmel & Natalie.—A. B. Cockran, of Natalie, Pa., is Chief Engineer of this Pennsylvania railway whose incorporation we noted March 28. The contracts have been let to J. C. Stanton & Co., of New York City.

Egg Harbor.—Work will soon be commenced on this railway from a point on the Camden & Atlantic R. R. to Gloucester Landing, N. J., 7 miles.

New York.—An offer has been made by New York capitalists to build a railway from Malone to Paul Smith's, N. Y., on condition that $30,000 be subscribed by the people of Malone.

SOUTHERN.—Existing Roads.

Macon, Dublin & Savannah.—It is expected to have this road completed from Macon to Dublin, Ga., by May 1. About 24 miles of the line are already in operation.

Birmingham, Sheffield & Tennessee River.—Surveys will soon begin for a line from Sheffield to Margerum, Ala., 22 miles. Construction will begin soon.

West Virginia Central & Pittsburgh.—Bids are asked until April 11 for grading 15 miles of the Gauley River Division of this road. The work is comparatively heavy. J. A. Feckenger, Weston, W. Va., Chief Engineer.

Decatur, Chesapeake & New Orleans.—This road was to be sold at auction sale April 7. The present status of the property is as follows: Seventeen miles south from Shelbyville, Tenn., of which two miles are finished, masonry for bridges completed, except part of one, and grading done, except about one mile; 31⅛ miles in Lincoln Co., Tenn., and 7½ miles in Madison Co., Ala., finished and ready for operation; 20 miles in Madison and Limestone Cos., Ala., graded, except gaps aggregating 1½ miles, with masonry and bridges nearly all partly built; 1 mile of completed road in Morgan Co., Ala., to the junction of the Louisville & Nashville and the Memphis & Charleston railroads, being about 44½ miles of completed road and about 37 miles graded, except about 2½ miles, and masonry nearly finished.

Norfolk & Western.—About 2½ miles of track is now laid on the Ohio Division from Kenova up Twelve Pole. The wet weather has greatly impeded the work. The bridge below Ceredo will be of iron and steel, "Bowstrings" pattern, 1,731 ft. long, 5 spans; channel span, 521 ft.; two spans on either side of channel, each 304 ft.; next two, each 301 ft.; base of rail, 100 ft. below extreme low water. The approach to the bridge through Kenova is by an iron viaduct 2,159 ft. long, carrying two tracks. The viaduct crosses the main line of the Chesapeake & Ohio Ry. at an elevation of 20 ft. above its tracks, at which point there will be a commodious union passenger station built of brick.

Roanoke & Southern.—This line will be opened for traffic to Martinsville, Va., April 15. The remaining 60 miles, between Roanoke and Martinsville, will be constructed from both ends. The steel bridges have been contracted for, and the material for construction is on the ground. This portion of the line is expected to be in operation in the early autumn. On the completion of this line it is proposed to extend the construction further south to Monroe.

Projects and Surveys.

Jellico, Beattyville & Ashland.—Chartered in Tennessee to build a line of railway from Jellico, Tenn., to Beattyville and Ashland, Ky., C. F. Davidson, President.

NORTHWEST.—Existing Roads.

Chicago, Milwaukee & St. Paul.—The preliminary steps have been taken for the construction of a line, by this company, from Appleton to Knowlton, Wis., via Waupaca, a distance of 70 miles. A survey was made by the company some time ago for a line from Berlin to Wausau. This, however, has been abandoned, as the survey was made before the company bought the Milwaukee & Northern road.

Projects and Surveys.

Western Construction Co.—This company has been chartered in Iowa with headquarters at Fort Madison. The business of the corporation shall be to build, equip and operate railways, to buy and sell stocks, bonds and securities of railways, and such other business connected therewith or incidental thereto as may be determined by the directors.

Winnipeg & Duluth.—This company will apply to the Dominion Parliament at the coming session for a charter to construct a railway from Winnipeg to the international boundary in a southeasterly direction. The company now holds a charter from the local legislature. The terminus of the road at Winnipeg will be between the C. P. Ry. and Northern Pacific stations. Offices will shortly be opened in that city.

Ontario & Rainy River.—The engineers which have been engaged all winter in surveys for this road have finished and are now at work preparing plans and estimates. The surveys cover that portion of the line from Iron Range Lake on the Port Arthur, Duluth & Western R. R. to the Atic-Okan River, a distance of about 80 miles, and penetrate a country almost entirely unexplored. The engineers report large deposits of iron and other minerals as existing.

Rainy Lake, Crookston & Pacific.—The following is the route of this road according to the articles of incorporation recently filed: From a point on Rainy Lake River or the international boundary line on Rainy Lake to the city of Crookston, and from Crookston in a southwesterly direction to the Southwest corner of Polk Co., thence westerly to the Pacific Ocean, or to a point of connection with some railroad already constructed and operated or in process of construction, to the Pacific Ocean or to some of the arms, sounds or inlets thereof, and also a branch line from or near the crossing of said road over the Big Fork River to Vermilion Lake, and thence to Lake Superior.

SOUTHWEST.—Existing Roads.

Red River & Southwestern.—The contract for constructing the first 30 miles of this road from Henrietta to Archer City, Tex., has been let to Murphy, Burkett & Co.

Projects and Surveys

Jefferson & Southwestern.—Chartered in Texas to build a railway from Jefferson, Tex., to some point on the Louisiana line near Wascom, a distance of 26 miles. Capital stock, $300,000.

Texas, Louisiana & Eastern.—Incorporated in Texas to build a railway from Monroe, Montgomery Co., to some point in Liberty Co., a distance of 40 miles.

Amarillo & Panhandle.—The people along the route are making efforts to secure the construction of a railway from Amarillo to Panhandle City, Tex., 28 miles.

ROCKY MT. AND PACIFIC.—Existing Roads.

Northern Pacific.—In regard to the work on the extension to South Bend the *Chehalis Bee* says:

Smith & Wilson, sub-contractors on the Chehalis South Bend road, have a force of 20 men clearing right of way on this end of the line. Feeney & McAuley have a subcontract on the bridgework and have about 15 men at work driving piles for the Chehalis River bridge. Webster, Kelso & Dare have about 60 graders at work near N. B. Ward's place. But little grading can be done while the rainy weather continues, but as soon as possible the force will be largely increased. About 500 men will be put to work at this end as soon as the weather clears so that they can be worked to advantage. No ballasting will be done until more of the road is built. The bridge across the Chehalis is the sticking point now, and as soon as it is passable railroad building will be rushed as fast as money and men can do it.

Projects and Surveys.

British Columbia.—Applications have been made for a charter to build a railway from Nanaimo to the north end of Vancouver Island, and also for one for a road from Victoria to a point on the Straits of Fuca to connect with the ferry to a point on opposite side and thus with the Northern Pacific system, whose trains are thus to run into Victoria.

CITY TRANSIT.

Electric Railways.—New lines or extensions are reported as probable in the following places: Salem, Ore.; Ballard, Wash.; Indianapolis, Ind., address J. P. Baker; Denver, Colo., address T. M. Kavanagh; Bay City, Mich., address the Electric Street Ry. Co.; Selma, Ala., address H. L. McKee; Portland, Ore., address A. D. Rockfellow; Pasadena, Cal.; Asheville, N. C., address the Asheville Loan, Construction & Improvement Co.; Macon, Ga., address American Loan & Investment Co.; Uniontown, Ala.; Atlanta, Ga., address H. L. Woodward.

Old Orchard, Me.—The Selectmen have granted the Biddeford & Saco R. R. Co. permission to operate that portion of its line within the village by electricity. No decision has yet been made in Biddeford, but Saco has given its consent.

Ransomville, N. Y.—Right of way for a 6-mile line from Rochester through Molyneaux, Ransomville and Youngstown to Lewiston. Among those interested are Rev. J. M. Fitzgerald, of Tiffany; E. S. Benedict, Rochester; S. P. Baker, of Youngstown; E. T. Ransom, Ransomville.

Trenton, N. J.—It is reported that the Trenton Horse R. R. Co. and the City Ry. Co. will be consolidated, and all the lines operated by electricity.

Philadelphia, Pa.—The Mayor has signed ordinances granting permission to the West Philadelphia Passenger Ry., the Philadelphia City Passenger Ry and the Philadelphia & Darby Passenger Ry. companies to operate their lines west of the Schuykill River by the trolley system. The plans of the Northern Passenger Ry. Co., controlled by the People's Line, have been approved by the Board of District Surveyors.

Allentown, Pa.—The Allentown & Bethlehem Rapid Transit Co. is reported to have secured the right of way for a line from Allentown through Hanover to Catasauqua.

Bristol, Tenn.—The Bristol Gas, Electric Light & Power Co. has bought the street railways here and will extend them, introducing electricity at the same time.

St. Louis, Mo.—The dummy lines of the St. Louis & Suburban Ry. will be changed to standard gage and operated by electricity. The cable line will also probably be changed to an electric railway, making in all a system of single and double track roads about 18 miles long.

Brownwood, Tex.—E. B. Goelet, box 156, wants prices for construction and equipment of an 8-mile line.

Dummy Railways.—*Gaffney City, S. C.*—Stacey & Pegues want prices for rails and engines.

Newman, Ga.—J. E. Brown wants estimates for building and equipping a line.

Augusta, Ga.—The Richmond Co. Belt Line Ry. Co. is reported as intending to build a line to Summerville and Murray Hill. The line will probably be standard gage, with 40-lb. rails. T. Murray will give particulars.

Salt Lake City, Utah.—C. S. Wilkes has secured a controlling interest in the West Side Rapid Transit Co., and will extend its lines to Eldorado.

Horse Railways.—New lines or extensions are reported as probable in the following places: Victoria, Tex., address J. E. Carpenter; Barnwell, S. C.; Hartford, Conn., address Hartford & Wethersfield Horse R. R. Co.; Dunkirk, N. Y., address Dunkirk & Fredonia Street Ry. Co.

Columbus, O.—It is reported that the Columbus Street R. R. Co. is being organized to build a 4-mile line.

Elevated Railway.—*Chicago, Ill.*—The South Side Elevated R. R. Co. has received permission from the Council to cross an alley near Twelfth St. This permission was long withheld, and its concession enables the company to extend its lines considerably.

New Companies.—Chicago North & South Elevated R. R. Co.; capital stock, $10,000,000; incorporators, J. A. Austin, G. G. Newbury and others. Toledo, Little Falls & Eastern R. R. Co., Tacoma, Wash.; capital stock, $250,000; incorporators, W. S. Bowen, W. E. Everette, J. M. Steele and others. Portland & Oregon City Ry. Co., Portland, Ore.; President, Dr. L. M. Davis; Secretary, H. M. Wasco.

HIGHWAYS.

Georgia.—The Board of Commissioners of Spalding Co. have completed plans for putting the convicts to work on the improvement of the roads.

Connecticut.—South Windsor wants improved roads, but has taken no definite action. At the last town meeting a motion was made that the selectmen should expend $2,000 per annum, but this was lost. It was stated that East Windsor, Manchester and Glastonbury, with a different system, had better roads at less expense. East Windsor formerly had a very expensive system, but has improved upon it. It was moved that a committee be appointed to inquire into the systems used in other towns, and, if they found one better than South Windsor's, recommend it. This proposition was voted down, and everything left to go on as before.

Illinois.—Representative Paddock has introduced a bill to secure the improvement of the public highways. It proposes the appointment of a non-partisan Board of State Highway Commissioners, to be composed of 3 members, to prepare all necessary maps, plans and specifications for the construction and maintenance of an improved system of highways in the several counties. It

requires the supervisors of each county to select the highways to be thus improved, and provides for the building of such roads under contract, for the issue of bonds and for the levy of a tax not to exceed five-one-thousandths of the assessed valuation of each county.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*St. Johnsbury, Vt.*—St. Johnsbury is agitating the scheme to connect two parts of its village with an iron bridge and viaduct 850 ft. long. The proposed structure will cost $30,000.

Randolph Co., W. Va.—Jesse T. Phares, civil engineer of Randolph Co., W. Va., will ask for bids for three new steel highway bridges across Tygart's Valley River at different points in that county. The bridges will have an aggregate length of 310 ft.

Natchitoches, La.—The citizens of Natchitoches are considering a proposition of the Chicago Bridge Co., La., to build a bridge across Cane River at their town for $14,000.

WATER-WORKS.

NEW ENGLAND.

Goffstown, N. H.—A bill authorizing the construction of works by the fire precinct has been introduced in the Senate.

Franklin Falls, N. H.—The town of Franklin has sold $80,000 of 4% bonds, it is reported, to G. A. Fernald & Co., Boston.

Rochester, N. H.—It is reported that a bill has passed the legislature authorizing the town to construct works. It is probable that the works of the company will be bought.

Falmouth, Mass.—A bill authorizing the Falmouth Highland Trust to take water from Long Pond is before the legislature.

Highlandville, Mass.—There is talk of securing a supply through an extension of the mains of the Needham works.

Manchester, Mass.—On April 4 the citizens voted, 135 to 12, to issue $125,000 of 25-year bonds for the construction of works.

Merrimac, Mass.—The project for a supply is still before the legislature.

Peabody, Mass.—About a half-mile of 6-in. pipe is to be laid. A new high-pressure pump has been proposed.

New Haven, Conn.—It is reported that the contract will soon be let for a dam and reservoir in the town of Bethany, on the west branch of West River. The proposed dam will be 450 ft. long, 40 ft. high and 132 ft. thick at the base. It will impound 160,000,000 galls.

Torrington, Conn.—The following is from O. R. Fyler, Superintendent:

A storage reservoir, with a capacity of 120,000,000 galls., to flood 41 acres, is to be constructed by the company. It will be formed by a dam 9 ft. high across the natural outlet of Whist Pond, in Goshen. To conduct the water from the new reservoir to the stream on which the present reservoirs are located 925 ft. of 12-in. and 2,800 ft. of 10-in. cast iron pipe will be laid, and about 600 ft. of open trench constructed. The company will also lay about 14,000 ft. of 8 to 4-in. pipe during the coming season.

MIDDLE.

Cohocton, N. Y.—An effort is being made to incorporate the village in order that water-works and other improvements may be introduced.

Niagara Falls, N. Y.—It is reported that the Cataract Construction Co., which recently bought the stock of the Niagara Falls Water-Works Co., will have new works in operation within a year. The pumping station will be located near the head of the tunnel.

Syracuse, N. Y.—Bids for $1,000,000 water bonds will be received by the City Treasury until April 20.

Union, N. Y.—A resident has sent the following:

The village is open to bids for a franchise, based on 25 hydrants. The proposed supply is from springs one mile distant. Population, 1,000. Address the village president.

New Jersey.—The American Water-Works Co. has filed articles of incorporation; capital, $3,000,000; place of business, New York and Jersey City; object, to build, own, etc., water-works and supply material; incorporators, Melville Egleston, Elizabeth, and others. The Union Debenture Co. has filed articles of incorporation; capital, $100,000, of which Stewart Tod, of New York, controls $980,000. Among its objects are the construction and operation of water-works in New York and New Jersey.

McKeesport, Pa.—The following is from J. Ecoff, Superintendent:

The Council has been asked to authorize an increase of the pumping plant, so that there may be added two 3,000,000-gall. compound condensing pumping engines, and a high service pumping station with two 1,500,000-gall. high pressure pumps.

Reading, Pa.—An issue of $100,000 of 4% 30-year bonds is proposed to pay for laying larger distributing mains.

Lonaconing, Md.—Works are projected.

SOUTHERN.

Chase City, Va.—W. K. Holt wishes prices on a pump to raise water from two 50-ft. wells and also on pipe.

Berryville, Va.—The following is from G. C. Thomas, President:

The Berryville Water Co. has contracted with R. D. Wood & Co., Philadelphia, for pipes, valves and hydrants and with J. P. Herdic, Williamsport, Pa., for construction. Work will be started about May 1. There will be a dam 80 ft. long, 10½ miles of mains and 30 hydrants. The supply will be by gravity. Population, about 2,000.

Roanoke, Va.—The appropriations of the council for the ensuing year include $18,000 for water-works construction.

Wilmington, N. C.—J. C. Chase, Superintendent, informs us that the contract for about 4,500 ft. of 12-in. pipe has been let to R. D. Wood & Co., and that the laying of the pipe is all that will be done this spring.

Atlanta, Ga.—About 5,000 ft. of wrought iron, and some 4-in. cast-iron pipe in 8-ft. lengths, is wanted by the Westview Floral Co.

Darien, Ga.—W. S. McIntosh, Clerk of County Commissioners, will receive bids until May 6 for a water tank 50 ft. high, with a capacity of $30,000 gal's.

Tennille, Ga.—Hartford, Heburt & Co., Chattanooga, Tenn., inform us that they have the contract for the city works here, and will begin construction about April 20. Water will be pumped from an artesian well to a tank or stand-pipe.

Uniontown, Ala.—Bonds to the amount of $25,000 have been issued for water and electric lighting works. The supply, as projected, will be pumped to a 15 × 80-ft. stand-pipe.

Union City, Tenn.—An attempt is being made to secure an amendment to the city charter which will allow the city to issue $60,000 for the construction of works.

Ashland, Ky.—J. M. Gardiner, General Manager, has sent the following:

The National Water Supply Co. has been incorporated to construct and deal in the stock, bonds and franchises of water-works and to manufacture and deal in material used in water-works construction.

NORTH CENTRAL.

Van Wert, O.—The following is a list of the successful bidders for works, partly in accordance with the recent advertisements in ENGINEERING NEWS, the information having been sent by John W. Hill, engineer, Cincinnati:

Pipe and specials, W. H. Pennel, Van Wert, $40,595; pipe laying, R. B. Carothers, Newport, Ky., $14,597; 81 6-in., 66 4-in. double nozzle hydrants, $3,749; valves, Rensselaer Manufacturing Co., Troy, N. Y., $1,540; stop-boxes, Bingham & Taylor, Buffalo, N. Y., $392; brick pumping station and chimney $13,555; 3,000,000-gall. earth reservoir, H. Merigold, Lima, O., $8,142; connection of drilled wells, E. A. Stimson & Co., Dayton, $2,759; total, $85,332.

Noblesville, Ind.—The following is from J. W. Smith, mayor:

The Council will receive bids for a franchise until April 22, the bids to be based on hydrant rental. The proposed system will include 75 double hydrants and 6 miles of 12 to 4-in. mains, but the latter shall be laid only with consent of the Council. There will be two 1,000,000-gall. pumps and two boilers. The supply will be from 2-in. "second water" wells. Bids are asked on direct pressure and stand-pipe system; the stand-pipe must be not less than 12 × 100 ft., with its bottom 40 ft. above street grade. The franchise will run for not over 25 years, and the city will retain the privilege of buying the works at the end of five years or at any time thereafter. Population, 4,000. U. B. McKinsey is City Clerk.

Centralia, Ill.—Water-works are still under consideration.

Elmhurst, Ill.—The Elmhurst Water Supply Co. will soon begin to lay pipe.

NORTHWESTERN.

Avoca, Ia.—J. J. Hipsley, Mayor, informs us that the contract for works as outlined in ENGINEERING NEWS of March 21, have been let to Godfrey & Meals, Fremont, Neb., for $11,500.

Creston, Ia.—The following is from E. A. Rudiger, Engineer:

Contracts for impounding reservoir dam, clear water basin and pump-house have been awarded to P. D. Watson & Co., Cameron, Mo.; for balance of pipe to Shickle, Harrison & Howard Iron Co., St. Louis, Mo. Contracts for boilers, filter and stand-pipe will be awarded later.

New Hampton, Ia.—Bids for works are wanted until April 14.

Girard, Kan.—J. S. James has sent the following:

New works are wanted, the present city plant being a tumble-down affair. A good franchise would be given, and a hydrant rental of $3,000 a year paid. Several franchises have been granted, but the parties have failed to build. Address the above.

McPherson, Kan.—The Western Water & Electric Light Co. has been incorporated; capital, $25,000. Works were built here by the town in 1883, and extended in 1888. Recently there has been talk of the purchase of the old works by a company.

Topeka, Kan.—It is reported that the Topeka Water Co. has begun the construction of improvements to cost $150,000.

Ponca, Neb.—A water-works election will be held April 17. Address William Lister or John Friday.

Great Falls, Mont.—The Belt Creek Water, Electric Light & Power Co. has been incorporated; capital, $25,000. The Great Falls Water Co. built works in 1889.

Canton, S. Dak.—It is reported that construction will soon be started.

SOUTHWESTERN.

Rockport, Mo.—A vote on the water-works question taken April 7.

Tarkio, Mo.—On April 6 the people voted regarding the construction of works.

Oklahoma, Ind. Ter.—We are informed that plans for works are being prepared by C. H. Ledlie, St. Louis, Mo. Water will be pumped to a tank.

Ballinger, Tex.—The following is from B. S. Taylor, Mayor:

The town proposes to let contracts, about May 10, for works estimated to cost $16,000. The supply will be pumped from Elm Creek to a 50,000-gall. tank. Population, 2,000.

Brownwood, Tex.—The following is from Carl Vincent, Secretary Board of Trade:

The proposed reservoir will flood about 100 acres, and will be formed by a dam 600 ft. long, having an average height of 50 ft.

San Antonio, Tex.—The construction of works to supply the west end of the city will be started at once. A reservoir will be constructed. Estimated cost, $50,000.

PACIFIC.

Anacortes, Wash.—The works are to be extended. S. W. Scott can give information.

Kent, Wash.—Proposals for a water-works franchise are asked by the council.

Dayton, Wash.—The following material will be required for the new works: Fifteen tons of specials; 15,500 ft. of 10, 3,779 ft. of 8, 4,935 ft. of 6 and 6,843 ft. of 4-in. wrought-iron pipe; 37 10 to 4-in. stop-gates; 40 6-in. double hydrants; 9 6-in. double and steamer nozzle hydrants. The reservoir will have a capacity of 600,000 galls., and the pipe to be taken up consists of about 1,800 ft. of 8 and 4-in. For further particulars see advertising columns.

Shelton, Wash.—The council has contracted with the Olympia Pipe Co. to put in about 10,000 ft. of pipe, from 8 ins. in diameter down to the 2-in. services. The price was $7,000 in bonds.

Sidney, Wash.—The following is from E. M. Taylor:

The village proposes to build works some time in the future at an estimated cost of $12,000. The supply will probably be pumped from Black Jack Creek to a tank. J. P. Thompson, President of the West Coast Engineering Co., Seattle, has charge of surveys. Population, 500.

Tacoma, Wash.—About $80,000 has been subscribed toward the proposed citizens' water company.

Waterville, Cal.—It is reported that works will be built at once by the Waterville Improvement Co., of which W. R. Ballard is President.

Astoria, Ore.—The Water Commissioners are considering the purchase of the present private works and the construction of additional or new works. The commissioners have authority to issue $500,000 of 6% bonds for works. The Astoria Water Co. has been incorporated by H. C. Thompson, E. Z. Ferguson and others; capital, $1,500.

Baker City, Ore.—The special committee has reported in favor of expending $3,000 for new mains, $1,000 for a pump and $4,000 for covering a reservoir and extending a wall.

Moscow, Ida.—T. J. Lamb, Superintendent, informs us, that in two or three months bids will probably be asked for a 14 × 100 ft. boiler steel stand-pipe.

CANADA.

Amherstburg, Ont.—J. H. C. Leggatt, Town Clerk, informs us that the contract for works has been awarded to Miles Hunting, of Hamilton, for $21,380. Water will be pumped from the Detroit River to a tank.

Exeter, Ont.—J. A. Rollins, Mayor, informs us that works are needed, but that so far they have merely been talked of. The probable source of supply is artesian wells.

Winnipeg, Man.—Alfred Pearson, Mayor, informs us that the city has named T. C. Keefer, Ottawa, Ont., as its arbitrator in determining the price to be paid for the water company's works.

FOREIGN.

Chihuahua, Mex.—George H. Utter, Silver City, N. M., informs us that he has received a franchise for water-works in this city. The population is estimated at from 20,000 to 25,000.

ARTESIAN WELLS.

Whitman, Mass.—The possibility of securing a water supply from artesian wells is to be investigated.

Belton, Tex.—The contract for a second well has been let, and work will be started at once.

Galveston, Tex.—J. W. Byrnes has begun to sink the 3,000-ft. artesian well, the start having been made with a 24-in. casing.

Santa Fe, N. M.—Superintendent Cart, of the Government Indian School, has been authorized to sink a well. It is thought that it will be carried down 1,000 ft.

IRRIGATION.

East Riverside, Cal.—The East Riverside Irrigation District wishes bids until April 22 for $1,500 6% 11 to 20-year bonds. Henry W. Robinson is President, and J. A. Van Arsdale is Secretary of the district.

New Companies.—Ordway Water Co., Denver and Ordway, Col., $10,000; Colorado Construction & Investment Co., Denver, Col., $100,000; Irrigation Machinery Co., Denver, Col., $60,000; Western Irrigation & Land Co., Hartland, Col., $250,000; Umatilla Land & Improvement Co., Portland, Ore., $10,000; A. L. Maxwell, J. N. Teal, Joseph Simon; Pine Irrigation Co., Summer Lake, Ore., $1,000; B. M. Cobb, A. Dent. Campbell & Moreland Ditch Co., Plano, Cal., $12,800; Directors, C. T. Brown, O E. Gibbons.

SEWERAGE AND MUNICIPAL.

Sewers.—*Laconia, N. H.*—The State Board of Health has recommended that a proper system of drainage be adopted.

Newton, Mass.—The sewage disposal has been settled by the Metropolitan Sewerage Commission, of Boston, but there is some objection to the sewerage ordinance, which regulates the method of assessment, and provides that the cost of maintenance, the proportionate cost of the Metropolitan system and the cost of the surface drainage system are to be borne by the city.

Providence, R. I.—Everson & Liddle, contractors for the intercepting sewers of the new system, have been relieved from liability on certain parts of the work, having been put to much cost and delay by quicksand.

Princeton, N. J.—It has been decided to have a sewerage system constructed at a cost of about $33,000.

Roanoke, Va.—The city engineer has been directed to prepare specifications of the sewerage of district No. 1.

Decatur, Ala.—An ordinance will be passed shortly providing for a system of sewers. For particulars address the mayor, Mr. H. S. Freeman.

Ashtabula, O.—Plans for sewerage for a part of the village has been prepared by Mr. H. E. Mann, city engineer. It is a gravity system, discharging into the river. It is expected to construct about 3 miles of sewers this season.

Indianapolis, Ind.—Contract specifications for sewer work have been prepared by Mr. Mansfield, City Engineer. They are modelled on the Cincinnati specification.

Baker City, Ore.—It is proposed to spend $30,000 for sewers and $3,000 for streets.

Streets.—*Dunkirk N. Y.*—It is proposed to lay vitrified firebrick paving on Central Ave.

Buffalo, N. Y.—It has been decided to have Main St. paved with asphalt. The work will be let to the Barber Co.

Beaver Falls, Pa.—The Town Council proposes to lay 3½ miles of vitrified brick paving next summer.

Roanoke, Va.—The street committee has recommended the making of 25 miles of macadamized streets. A report on improved methods of paving has been made by Mr. Dunlap, City Engineer.

Augusta, Ga.—Broad St. is to be paved with vitrified brick, the property owners and the city each paying half the cost.

Bonds.—Bonds for public improvements are proposed as follows: Beaver Falls, Pa., $200,000 for sewers and streets. Boise City, Idaho, $50,000 for sewers, $40,000 for city hall. West Troy, N. Y., $50,000 for paving, bids to be received by the Chamberlain, April 16. Athens, Ga., $75,000 for streets and sewers. Cincinnati, O., $500,000 for extending Albert Ave. Detroit, Mich., $1,250,000 for improvements. San Luis Obispo, Cal., $50,000 for sewers, bridges, etc. Marshall, Ia., $100,000 for improvements. New Berne, N. C., $35,000 for sewers and $25,000 for streets, vote to be taken May 4. Salisbury, N. C., $50,000 for streets, etc.; address the Mayor.

Lighting.—The Troy Gas Co., of Troy, N. Y., has a contract for street lamps outside the electric lighting district at 8 cts. per lamp per night, and $1.50 per 1,000 cu. ft. for the City Hall. The Oakland Gas, Light & Heat Co. has placed a mortgage for $1,000,000 with the California Safe Deposit & Trust Co., and will make extensive improvements to the plant.

ELECTRICAL.

Electric Light.—New plants or extensions are reported as probable in the following places: Dallas, Tex., address the Dallas Construction Co.; Aiken, S. C., address J. G. Gardner; Pineville, Ky., address J. S. Ray; Huntsville, Ala., address the Huntsville Electric Co.; Syracuse, N. Y., address the Onondaga Electrical Co.; McMinnville, Tenn., address the Mayor; Kingston, Tenn., address Mayor A. B. Anderson, East Tawas, Mich.; Granville, O.; Luling, Tex.; Brenham, Tex.; Newbury, S. C.; Rome, Ga., address the Rome Gas Light Co.; Ennis, Tex.; Pulaski, Tenn.; Clarksdale, Miss.; Wardner, Id.; Winchester, N. H.; Niles, O.

Hamilton, Ont.—The plant of the Electric Light & Power Co. will be sold at auction April 15. It includes Thomson-Houston and Westinghouse machinery of 400 arc and 2,500 incandescent lights capacity.

Wheeling, W. Va.—Bids are wanted for supplying this city with a complete electric light plant. Details will be found in our issue of March 7.

Reno, Nev.—The Reno Electric Light & Power Co. is reported to have purchased a site for a $15,000 power plant.

New Companies.—Dawn Electric Co., Chicago, Ill.; capital stock, $20,000; incorporators, H. P. Williams, J. A. McEnter, J. M. Glenn. Montauk Electric Light Co., Brooklyn, N. Y.; capital stock, $50,000; trustees, A. L. Hough, W. J. Stitt, J. Honigas. Clinton Gas & Electric Co., Clinton, Mo.; capital stock, $8,000; incorporators, J. T. Marsh, G. C. Haysler, E. L. Foote and others. Neihart Electric Light & Power Co., Neihart, Mont.; capital stock, $20,000; incorporators, S. Pierse, E. G. Hanson, W. G. Rowen, C. M. Shaw. Bridgeport, Ala., Electric Light & Ice Co.; capital stock, $60,000; incorporators, A. L. Soulord, E. A. Hoffman, Jr., F. L. Kilpatrick. Barnwell, S. C., Electric Light & Power Co.; capital stock, $5,000; incorporators, G. D. Bellinger, M. Brown, G. K. Ryan. Bay City Gas, Water & Electric Works, Lodi, Cal.; capital stock, $100,000; incorporators, G. G. Buckland, J. D. Fisk, S. T. Dodson.

CONTRACTING.

Jetties.—*Galveston, Tex.*—Proposals for the delivery of about 1,000,000 tons of stone and concrete blocks in place for improving the entrance to the harbor, with a railway track upon the jetties, were opened March 30 by Major Charles J. Allen, U. S. Engineer Office. A list of the bids received Dec. 27, 1890, was given on pages 45 and 72. The quantities include 34,500 ft. of railway, including trestle; 220,000 tons of riprap in the south and 518,000 tons of riprap in the north jetty; about 115,000 tons of stone or concrete blocks, weighing from ¾ to 10 tons each in the south jetty and about 263,000 in the north jetty. The bidders are as follows: A, Samuel Hawks, New York, N. Y.; B, John P. Nelson, San Antonio, Tex.; C, B. Lantry & Sons, Strong City, Kans.; D, Henry Bennett, Topeka, Kans.; E, John F. Gayner, Fayetteville, N. J.; F, Ricker, Lee & Co., Galveston, Tex.; G, O'Connor, Laing & Smoot, Dallas, Tex.

	Sandstone per ton.	Granite, per ton.	Concrete blocks, per ton.	Total for sandstone and railway.	Total for granite and railway.
A.	$2.70 to 3.25	$4.27 to 4.57	$4.27 to 4.57	$3,042,189	$4,919,274
B.	2.59 " 4.75	3.75 " 4.70	7.00 " 7.50	3,400,935	4,694,307
C.	2.47 " 2.47	3.65 " 4.74	2.47 " 4.74	2,849,064	4,557,814
D.	2.30 " 3.57	3.76 " 5.00	4.40 " 5.00	3,066,931	4,678,463
E.	2.45 " 5.00	4.40 " 4.70	5.00 " 6.00	3,732,200	5,061,780
F.	2.50 " 3.00	3.90 " 4.70	5.00 " 5.25	3,057,600	4,553,940
G.	2.45 " 2.80	4.00 " 4.40	5.00 " 6.25	2,922,150	4,613,610

Street Work.—*Beatrice, Neb.*—Contracts have been awarded as follows by Mr. O. V. P. Stout, City Engineer: 9,835 sq. yds. of paving, with two courses of brick, on sand, J. S. Rutherford, $1.44 per sq. yd.; 3,191 ft. of Colorado red sandstone curbing, 20 × 5 ins., H. W. Shepard, 73 cts. per lin. ft.; 28 corner blocks, 24 × 20 ins., H. W. Shepard, $4 each. The engineer's estimates were $1.55 75 cts. and $4.

Easton, Pa.—The following proposals for about 3,500 sq. yds. of vitrified brick paving have been received by Mr. A. J. Cooper, City Engineer: T. M. Lesher & Son, Easton, $2.30 per sq. yd. for paving, 70 cts. per lin. ft. for 4-in. curbing; J. M. Mack, Philadelphia, $2.25, 70 cts.; C. M. Porter, Easton, $2.30, 60 cts. The contract was awarded to T. M. Lesher.

Montgomery, Ala.—The following proposals have been received for furnishing granite blocks and laying pavement: Southern Granite Co., $2.67 to $3.82 per sq. yd. Venable Bros., $2.30 to $3.50. For furnishing granite blocks: Southern Granite Co., $71 per 1,000; M. E. Mayer, $76 and $77 20.

Oakland, Cal.—Prices of bids recently received ranged from 12½ to 15⅝ cts. per sq. ft. for bituminous pavement, 89 cts. to $1.15 per lin. ft. for granite curbing, and 13½ to 20 cts. per sq. ft. for cement sidewalks.

Providence, R. I.—Contracts for material have been awarded as follows: Sewer pipe, C. M. Kelly, Jr., of Providence; flagstones, Manchester & Hudson, of Providence; catch-basin stones, J. W. Mathewson, of Greenville, R. I.

Sewers.—*Albany, N. Y.*—The Board of Contract has awarded contracts as follows: Vitrified pipe drain in Irving St., R. H. Strong, 79 cts. per ft. for 12-in. pipe, $2.23 each for Y branches, 2½ cts. per ft. for extra trenching; manholes, $45 each; lampholes, $10 each. Vitrified pipe drain in Bleecker St., Wm. E. Murphy, 6, 12, 17 and 16 in. pipe, 60 cts., $3.30, $3.40 and $6 per ft.; 12 and 15 in. Y branches, $6 and $7; extra trench and old sewer, 70 cts. per ft.; extra trench, 20 cts. per ft.; manholes, $60 each; lampholes, $15 each; receiving basins, $90 each.

Newark, N. J.—Contracts have been awarded as follows by Mr. E. Adam, City Surveyor: New Jersey Ave., P. H. Harrison, 12, 15 and 18-in. pipe, 60 cts., 75 cts. and $1 per ft.; manholes, $32 each; basins, $90 each. South Canal St., P. H. Harrison, 12-in. pipe, 94 cts. per ft; manholes, $34; basins, $94. Madison St., James Edwards, 53 cts. per ft. for 12-in. pipe; $26.35 for manholes, $74 for basins.

Dredging.—*Richmond, Va.*—The following proposals for dredging in the James River were received April 1, by Col. Wm. P. Craighill, U. S. Engineer Office: J. T. Vaughan, Richmond, Va., 44 cts. per cu. yd. for sand, $3 per cu. yd. for bowlders, $1 per lin. ft. for logs. C. T. Caler, Norfolk, Va., 44¾ cts., $3 and $1.03.

PROPOSALS OPEN.

Track Material.—*Chicago, Ill.*—For freight tracks in and about Jackson Park. Steel rails, angle bars, bolts, spikes, switches, frogs, ties, etc. D. H. Burnham, Chief of Construction of World's Columbian Exposition, The Rookery. April 13.

Dredging.—In Manistee River and harbor, about 50,000 to 60,000 cu. yds. Maj. Wm. Ludlow, U. S. Engineer Office, Grand Rapids, Mich. April 28.

In Darien harbor, Brunswick harbor and Jekyl Creek, Ga. Lieut. O. M. Carter, U. S. Engineer Office, Savannah, Ga. April 20.

In North River, about 13,500 cu. yds. at piers 41 and 45. The Docks Department, Pier A, North River, New York, N. Y. April 16.

Street Work.—*New York, N. Y.*—Flagging, curbing and granite block paving on concrete. Department of Public Works, 31 Chambers St. April 20.

Dams, Etc.—Stone for abutment for a dam in the Wabash River near Mt. Carmel, Ill. Capt. E. Maguire, U. S. Engineer Office, Louisville, Ky. April 29.

Brush and pile dam in San Joaquin River, near Grayson, Cal. Maj. W. H. Heuer, U. S. Engineer Office, San Francisco, Cal. April 25.

Brush, fascines, poles and rock for jetty at entrance to Coos Bay. Capt. T. W. Symonds, U. S. Engineer Office, Portland, Ore. May 5.

Lighting.—*New York, N. Y.*—Gas or other material for streets, parks and public places from May 1 to Dec. 31, 1891. Department of Public Works, 31 Chambers St. April 15.

Dock Work.—*New York, N. Y.*—Extending pier No. 37, North River; building crib bulkhead; furnishing granite stones for bulkhead or river wall. Department of Docks, Pier A, North River. April 23.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Rogers Locomotive Works, of Paterson, N. J., are building 5 engines for the Norfolk & Western. The Baldwin Locomotive Works, of Philadelphia, Pa., are building 40 mogul and 8 consolidation engines for the Northern Pacific, and 25 engines for the Norfolk & Western. The Rhode Island Locomotive Works, of Providence, R. I., are building 15 engines for the Milwaukee, Lake Shore & Western. The Schenectady Locomotive Works, of Schenectady, N. Y., have delivered 14 ten-wheel engines to the Chicago, St. Paul, Minneapolis & Omaha. A logging engine is wanted by C. J. Stewart, Lomax, Ala.

Cars.—The Middletown Car Works, of Middletown, Pa., have a large order for gondola cars. The Wells & French Car Co., of Chicago, Ill, has a contract for 350 coal cars of 30 tons capacity for the Columbus, Shawnee & Hocking. The Pullman Palace Car Co., has built a private car for the president of the Boston & Maine R. R. It is 65 ft. long, and is carried on six-wheel trucks.

Station.—The Chesapeake & Ohio Ry. Co. has let contracts for a $10,000 brown stone and brick station at Hinton, W. Va.

Steel Works.—The Steel & Iron Improvement Co., of Pittsburgh, Pa., will build works at Glenford for the manufacture of blister steel by the Adams process, which is said to be much cheaper than the process generally employed.

The Standard Bridge & Boiler Co., of Bellaire, O., has been incorporated, and is erecting its works. President, Edward Jones; Secretary, Samuel Simmons. J. E. Jarold will have charge of the mechanical department. Capital stock, $100,000.

Pumping Engine.—The Quincy Mining Co., of Hancock, Mich., has purchased a Worthington high duty pumping engine of 10,000,000 galls. daily capacity. Diameter of high and low pressure steam cylinders, 23 and 46 ins.; of double acting water plungers, 27½ ins.; all of 36 ins. stroke.

Companies.—Burrell Electric Signal Co., of Jersey City, N. J.; incorporators, S. F. and C. F. Burrell, of Brooklyn, N. Y., and Wm. C. Joy, of New York, N. Y.; capital stock, $500,000. Union Debenture Co., of New York, N. Y.; to construct and equip railways, waterworks and other public works; incorporators, Chas S. Tod, of New York, A. P. Gifford, of Newark, and John R. Outwater, of Hawthorne N. J.; capital stock, $100,000. Eureka Nut Lock Co., of Pittsburg, Pa.; incorporators, Wm. R. Hays and John W. Parke; capital stock, $30,000. American National Water-Works Co., of Trenton, N. J.; capital stock, $3,000,000. Brayton Motor Co., of Chicago, Ill.; to manufacture the Brayton hydro-carbon engine; incorporators, C. Robinson Holmes, G. L. Dickinson and Eugene White; capital stock, $500,000. Smead Warming and Ventilating Co., of Chicago, Ill.; incorporators, S. L. Bailey and F. M. Bailey; capital stock, $100,000.

Metal Market Prices.—*Rails.*—New York: $30.75 to $31; old rails, $24.50 for iron and $17 for steel. Pittsburg: $26.50 to $27; old rails, $24 to $24.50 for iron and $17.50 for steel. Chicago: $31; old rails, $23.25 for iron and $17 for steel.

Track Materials.—New York: steel angle bars, 1.7 to 1.8 cts.; spikes, $1.9 to $1.95; track bolts, 2.75 cts. with square, and 2.9 cts. with hexagon nuts. Pittsburg: splice bars, 1.9 to 2 cts. for iron or steel; iron or steel spikes, 2.05 cts.; iron track bolts, 2.8 cts. with square, and 2.9 cts. with hexagon nuts. Chicago: splice bars, 1.85 to 1.9 cts. for iron, 2 to 2.05 for steel; spikes, 2 to 2.1 cts.; track bolts, 2.85 cts. with hexagon nuts.

Foundry Pig Iron.—New York: $14 to $16. Pittsburg: $15 to $17. Chicago: $14.50 to $16.

Pipe.—Cast iron, $25 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 50 per cent. on black and galvanized butt-welded; 67½ and 55 on black and galvanized lap-welded. Casing, 55 per cent.

Lead.—New York, 4.3 to 4.32½ cts. Chicago, 4.15 cts. St. Louis, 4.1 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 to 2.1 cts.; tees, 2.5 to 2.75 cts.; sheared iron plates, 2.05 to 2.25 cts.; steel plates, 2.05 to 2.15 cts. for tank, 2.35 to 2.6 cts. for shell, 2.6 to 2.7 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.05 cts.; tees, 2.85 cts.; universal iron mill plates, 2.1 cts.; sheared steel bridge plates, 2.3 cts.; refined bars, 1.85 to 1.9 cts.; steel plates, 2.2 cts. for tank, 2.55 cts. for shell, 2.75 cts. for flange, 4.25 to 4.5 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.25 to 2.5 cts.; tees, 2.7 to 2.85 cts.; universal plates, 2.3 to 2.4 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.6 to 2.7 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange, 4.25 to 5.5 cts. for firebox; boiler rivets, 4 to 4.25 cts.